QK1
.A423
v.9
1924/25

THE AMERICAN MIDLAND NATURALIST

DEVOTED TO NATURAL HISTORY, PRIMARILY
THAT OF THE PRAIRIE STATES

JULIUS A. NIEUWLAND, C.S.C., PH.D., SC.D.
EDITOR

VOLUME IX—1924-25

UNIVERSITY OF NOTRE DAME
NOTRE DAME, INDIANA

MISSOURI BOTANICAL
RECEIVED
OCT 15 1926
GARDEN LIBRARY

INDEX

Anatomy—
Apios tuberosa Moench ____ 118
Comandra Umbellata ____ 1
Angiospermae ____ 387
Apios tuberosa Moench ____ 118

Bacillariophyta ____ 254
Birds—
Ecological Associations ____ 569
Floyd County ____ 65, 75
Iowa ____ 65
Migration ____ 65
Relations ____ 564, 595
Texas ____ 564, 595
Vegetation ____ 564, 595
Winter ____ 68
Book Reviews—
Ancient Man in Britain ____ 144
Annotated List of the Ferns and Flowering Plants of New York State ____ 319
Boy's Own Book of Science ____ 99
Dwellers of the Sea and Shore ____ 99
Entomology, Textbook ____ 529
Everyday Mysteries ____ 99
Fern Lover's Companion ____ 98
Guide to the Trees ____ 529
Humanizing of Knowledge ____ 98
Man's Prehistoric Past ____ 144
Nature Magazine ____ 144
Outline of Science ____ 142
Pierre Curie ____ 146
Western Birds ____ 147
Botany—
Gleanings in Michigan II ____ 295
Research, Cold Spring Harbor ____ 548
Brooklyn Institute of Arts and Sciences ____ 195

Children's Museum ____ 195
Chlorophyceae ____ 289
Climate, Long Island ____ 546
Cold Spring Harbor
Flora ____ 245, 283, 384, 513, 550
Geology ____ 531
Comandra Umbellata (L.) Nutt
Anatomy ____ 1
Bibliography ____ 10
Inflorescence ____ 3
Reproduction ____ 2
Vegetative Organs ____ 6
Conjugatae ____ 287

Diamond, Story of ____ 176
Dinoflagellatae ____ 286

Ecology, Birds and Plants in Texas ____ 569
Education, Premedical ____ 80

Erie, Lake ---101
Euphorbia corollata L. ---161
ipecacuanhae ---156
maralandica Greene --149, 163
forma albo-marginata ---166
vegetative organs ---169

Fall Freeze, in Plants --- 14
Fauna, Naiad ---321
Tennessee ---321
Flagellatae ---285
Flora ---381
Flora, Cold Spring Harbor
245, 283, 384, 513, 550
Bibliography ---550
Flora, Fossil ---513
Flowers, Springtime ---379
Floyd County Birds—
Bibliography --- 75
Spring Migration --- 65
Winter --- 68
Form, New Polygonatum ---663
Fossil Flora ---513
Freeze, Fall --- 14

Galls, Insect ---524
Geology, Cold Spring Harbor 531
Gleanings, Botanical ---259
Grouse, Ruffed ---373
in Pennsylvania ---373
Status ---373
Gymnospermae ---386

Helianthus kentuckiensis
description ---139
Helianthus, Kentucky --- 137
Helianthus, New ---137
Herbs, Hibernation ---439, 477
Rejuvenation ---439, 477
Hibernation, North American
Herbs ---439, 477

Inflorescence, Comandra
Umbellata --- 3
Insect Galls ---524

Kentucky, New Helianthus --137

Lake Erie, Naiades ---101
Life, Bird ---564, 595
Long Island—
Biblography of Flora ---550
Climate ---546
Geology ---531
Soils ---544
Vegetation ---544

Michigan, Botanical Gleanings 529
Migration, Floyd County Birds 65
Museum, Children's ---195
Myxomycetes ---250

Naiades
Distributional Features ---101
Lake Erie ---101
Tennessee --- 18, 321
New Form of Polygonatum--661
New Helianthus of Kentucky 137
New Viburnum ---192
North American Herbs --439, 477

Organs, vegetative, of
Comandra umbellata --- 6

Pennsylvania Ruffed Grouse--373

Plants, Ecological Associations 569
Fall Freeze ---- 14
Polygonatum, New Form ---- 661
Premedical Education ---- 80
Pteridophyta ---- 384

Rejuvenation, North American Herbs ---- 439, 477
Relations, Bird Life ---- 564, 595
Vegetation ---- 564, 595
Reproduction, Comandra umbellata ---- 2
Research, Botanical ---- 548
Ruffed Grouse ---- 373

Schizophyta ---- 246
Status of Ruffed Grouse in Pennsylvania ---- 373
Soils, Long Island ---- 544

Tennessee Naiad-Fauna ---- 18, 321
Texas—
Bird Life ---- 564, 595
Ecological Associations ---- 569
Plants ---- 569
Vegetation ---- 564, 595

Vegetation—
Bird Life ---- 564, 595
Long Island ---- 544
Relations ---- 564, 595
Texas ---- 564, 595
Viburnum Ashei ---- 192
Viburnum, New ---- 192

Walden Gorge ---- 321

CONTENTS

Comandra Umbellata (L.) Nutt—*Theo. Holm* ---------- 1
Some Effects of the First Fall Freeze—*O. A. Stevens* ---------- 14
The Naiad-Fauna of Duck River in Tennessee—*Dr. A. E. Ortmann*- 18
The Birds of Floyd County, Iowa—*Carroll Lane Fenton* ---------- 65
On Premedical Education with Especial Reference to the Viewpoint of Class A Medical Schools—*N. M. Grier, Ph. D.* ------ 80
Distributional Features of Naiades in Tributaries of Lake Erie—*Dr. A. E. Ortmann* ----------101
Apios tuberosa Moench—*Theodore Holm* ----------118
A New Helianthus from Kentucky—*Frank T. McFarland* and *W. A. Anderson, Jr.* ----------136
Euphorbia Marilandica Greene—*Theodore Holm* ----------149
The Story of the Diamond—*H. D. Crider,* University of Kentucky-176
A New Viburnum—*B. F. Bush* ----------192
The Children's Museum of the Brooklyn Institute of Arts and Sciences 195
The Native Flora of the Vicinity of Cold Spring Harbor 246, 283, 384
Botanical Gleanings in Michigan II—*Oliver Atkins Farwell* ------259
The Naiad-Fauna of the Tennessee River System Below Walden Gorge—*Dr. A. E. Ortmann* ----------321
The Present Status of the Ruffed Grouse in Pennsylvania—*George Miksch Sutton* ----------373
A Few Springtime Flowers—*Mary Hovey* ----------379
The Flora of an Historic Wall—*Donald Culross Peattie*----------381
Hibernation and Rejuvenation, Exemplified by North American Herbs—*Theodore Holm* ---------- 439, 477
The Fossil Flora of the Vicinity of Cold Spring Harbor—*N. M. Grier* ----------513
The Geology of Long Island With Especial Reference to the Cold Spring Harbor Region and Its Flora—*N. M. Grier*----------531
The Relations of Vegetation to Bird Life in Texas—*Harry C. Oberholser* ---------- 564, 595
An Unusual Polygonatum—*Sister Vincent de Paul—McGivney, I. H. M.* ----------663
Book Reviews ---------- 98, 142, 319, 529

The American Midland Naturalist

PUBLISHED BI-MONTHLY BY THE UNIVERSITY
OF NOTRE DAME, NOTRE DAME, INDIANA

VOL. IX. JANUARY, 1924. NO. 1

Comandra Umbellata (L.) Nutt.

THEO. HOLM.

(With 12 figures drawn by the author.)

Six species are known of the genus *Comandra* Nutt.: *C. elegans* (Roch.) Rchb. fil. from central Europe, *C. umbellata* (L.) Nutt., *C. Richardsiana* Fernald, *C. pallida* A. D C., *C. californica* Eastw. ined., and *C. livida* Richards from North America. They represent two distinct sections, as already pointed out by W. I. Hooker, based upon the structure of the flower: "the whole tube of the calyx being incorporated with the germen" (*C. livida*) ; and: only the lower part of the tube being united with the ovary" (*C. umbellata* and the other species). Another distinction is pointed out by Bentham and Hooker viz., "fructu globoso maturo denudato, exocarpio succulento (*C. livida*), and: "fructu ovoideo parum carnoso perianthii reliquiis coronato (the others) ; the former section is called "*Haplocomandra,*" the latter "*Eucomandra.*" Regarding the habit they are suffrutescent and provided with a horizontally creeping rhizome, at least the American species; the rhizome of the European species is neither described nor figured by Reichenbach.

The floral structure is very complicated, and although Eichler, Bentham and Hooker have defined the floral envelope as a perianth, Gray and subsequent authors speak of a calyx; the peculiar structure of the rhizome has not been touched upon except "rootstock under-ground," and the anatomical structure is but imperfectly known. For this reason we have re-examined *C. umbellata,* which is frequent in our vicinity, and the following notes based upon fresh material, may be of some interest to students of plant-morphology. We regret,

however, that we have been unable to trace the life-history from the seedling-stage, and that we have never observed a single case, that would demonstrate the parasitic habit of the species in spite of its generally abundant occurrence. The geographical distribution extends from central Maine to Wisconsin and Georgia; it grows in sandy or gravelly soil, in open thickets, frequently associated with *Rhus quercifolia, Tephrosia virginiana, Epigaea,* etc.

THE VEGETATIVE REPRODUCTION.

The accompanying four drawings (Figs. 1-4) are small, but sufficient for illustrating the vegetative reproduction. Rhizomes measuring in length until 50 cm. are frequent, but they are not more instructive than the small ones figured. Characteristic of the rhizome is the horizontal growth, the scant development of roots with haustoria, the very irregular development of lateral, subterranean branches, and of aerial, erect, flower-bearing shoots; moreover the subterranean leaves are very small, scale-like, and membranaceous, of very short duration, and leaving no scars upon the rhizome. This in connection with the fact, that the whole rhizome is of a grayish-brown color with the surface very uneven from the numerous layers of cork renders the external structure more similar to a root with root-shoots than a stem.

Figure 1 thus shows a mature rhizome of which the terminal bud (B) is still dormant; behind the bud are four flower-bearing shoots (S) of which only the basal internodes have been figured. The very irregular development of the shoots is readily noticeable, buds and aerial shoots being mixed without any order. The short roots appear generally close to the buds. In figure 2 we have shown the horizontal, creeping apex of a rhizome with a terminal bud, and with several young, secondary roots. A similar structure was observed in some other rhizomes, but in these the terminal portion was ascending, and had developed into a flower-bearing shoot. The branches of the rhizome, which remain under-ground (Fig. 3), are relatively stout, and the leaves may be observed upon these during the fall. Then we have also a reproduction by means of buds developed in the axils of the basal leaves of the aerial

shoots (Fig. 4), and these buds will develop into aerial shoots next year, floral as well as purely vegetative; as many as five flower-bearing shoots may be found developed from the base of a single stem of the year preceding. The vegetative reproduction is thus very highly exemplified in this species, presumably at the expense of the floral reproduction, since the number of fruits developed is remarkably small in proportion to the abundance of the flowers. Corresponding cases are known from several other plants, for instance from *Apocynum, Asclepias* and *Acerates,* where constantly only one or two fruits are developed in the rich-flowered infloresence; but in these the vegetative reproduction is confined to the root-system, developing root-shoots in abundance, while these plants are totally destitute of rhizomes in the stricter sense of the word.

THE INFLORESCENCE AND THE FLOWER.

According to Eichler the inflorescence of the *Santalaceae* is principally botrytic (raceme, spike or capitulum) since the prophylla, when altogether present, are mostly without axillary flowers; but when the prophylla are fertile, the single, lateral axes may become changed to cymes of the dichasial type as is the case in *Comandra* and several species of *Thesium.* In *Comandra umbellata* the upper stem-leaves subtend two to three-flowered cymes, and the prophylla are small, but green; in the two-flowered cymes the median has aborted. Sometimes we may find an inflorescence with the axillary branches bearing secondary cymes, and the accompanying diagram illustrates a case of that kind; the central flower is not developed. This inflorescence is borne upon a distinct peduncle (about 10 cm. long), and, as shown in the figure, (Fig. 6) there are two pairs of large, opposite bracts (L^1 and L^2), L^1 being the larger. The apical flower is aborted, but in the axil of the two smaller bracts (L^2) a single flower is developed, none of which are provided with prophylla. Finally in the axils of the two larger bracts (L^1) a secondary three-flowered cyme is developed, borne upon a distinct peduncle, and overtopping the central flowers. These secondary cymes begin with a pair of prophylla (P), situated to the right and left of the central flower, and

each subtending a flower. This inflorescence, exceptional as it be, thus shows, that a regular cyme with bracts may occur in *Comandra umbellata*, and that the development of the bracts may, to some extent, result in the suppression of the prophylla of the central system of flowers.

Now with respect to the flower, this is typically pentamerous in Comandra, but tetramerous flowers occur also, as shown in the two flowers, drawn in the diagram (Fig. 6). In such tetramerous flowers the perianth-leaves and the stamens form a cross diagonally with the axis. It is not uncommon in *Comandra umbellata* that the inflorescences are only two-flowered, but the pentamerous structure is always the most frequent, and the typical of the genus.

The morphological interpretation of the floral organs in the *Santalaceae* has been discussed very extensively, and the opinions expressed are at great variance. Eichler gives the history of this subject, and the difficulty depends on defining the floral leaves as representing a calyx, a corolla or simply a perianth, in which the petals are undeveloped. While many authors have expressed the opinion, that the flower has only a calyx, Alph. De Candolle and Baillon considered the flower as being asepalous; Eichler, on the other hand, prefers to define the floral envelope as simply a perianth. Regarding the definition of the floral leaves representing a calyx, this is only based upon the fact that the stamens are always opposite the perianth-leaves; we must remember, however, that in none of the genera of the family does there exist a single case, where an inner whorl of leaves is present, alternating with the stamens. The view expressed by De Candolle, that the calyx has aborted, seems more justified, because the position of the perianth-leaves being 2-3, besides that the frequent diagonal crossing agrees better with a corolla than with a calyx; furthermore as demonstrated by Baillon the segments of the perianth are developed simultaneously. De Candolle believed also that the small denticulations in the flower of *Choretrum* indicated traces of a calyx, and he compared these with the plainly developed foliar organs in the pistillate flower of *Buckleya* "ad demonstrationem natum genus." An analogous instance is cited by Baillon from *Lavallea*, but this genus has

since been referred to the *Olacineae* by Bentham and Hooker, and according to Eichler's opinion *Buckleya,* which De Candolle raised to a tribe of its own, ought also be placed in this family, *Olacineae.* And with regard to the denticulations in *Choretrum,* Eichler considers it a question, whether these really are rudimentary leaves or whether they merely represent processes of the superior margin of the ovary. Similar formations are known also from the *Loranthaceae,* where they are called "calycodium" as suggested by Planchon and Decaisne. The simultaneous development of the perianth-leaves is according to Eichler no proof of their morphological identity being a corolla, because such is also the case of the non-ambiguous calyx of *Stellatae, Valerianeae, etc.;* with respect to the position being 2-3 in the pentamerous flowers, as pointed out by De Candolle, this same position occurs also in the calyx of *Lobeliaceae, Rhodoraceae, Papilionaceae,* etc. Taking these various points into consideration Eichler prefers to designate the floral envelope neither as a calyx nor a corolla, but as a simple perianth, characteristic of which is the simultaneous development of the leaves, and the frequent diagonal position of these to the axis in the tetramerous flowers.

Finally with respect to the position of the stamens being opposite to the perianth-leaves, a structure, which recurs in the *Loranthaceae,* Hofmeister and Van Tieghem considered stamen and perianth-leaf to represent a simple phyllom. The latter author, who studied the anatomical structure of the flower of the *Santalaceae,* observed only one mestome-strand in this organ, and reached the conclusion: "L'ètamine y est une dependance vasculaire de la face interne du sépale." According to Eichler stamen and leaf represent two organs, which have grown together; as a matter of fact both organs may be observed as almost separate in various species of *Viscum,* etc., besides that flowers with three perianth-leaves and with only two stamens may be found occasionally, in which one of the stamens is situated between two of the perianth leaves. The morphological construction of the flowers of the *Santalaceae* as well as the inflorescence, and the vegetative reproduction offer many points of interest, still, renewed inves-

tigations and observations on fresh material would undoubtedly add numerous others.

INTERNAL STRUCTURE OF THE VEGETATIVE ORGANS.

The Roots.—As mentioned above the roots are short, sparingly branched, and provided with haustoria; they remain active for more than one year, but increase very little in thickness. The increase is effected by the pericambium developing cork and secondary cortex, thus the epidermis and the primary cortex become partly thrown off, or collapse. The primary cortex is thinwalled, homogeneous, and contains no deposits of starch. The cork represents a broad zone, thinwalled throughout, and surrounds a secondary cortex, rich in starch, and containing two small strands of stereome, located outside the two primary strands of leptome. The stele represents an almost regular, quadrangular (in cross-sections) group of hadrome with four short rays of vessels and with thickwalled conjunctive tissue extending to the center of the stele. The leptome represents four very distinct strands, but only the two of them are supported by stereome. There are several strata of cambium visible between the leptome and hadrome, thus the increase within the stele itself is more slowly advancing than in the peripheral tissues, the secondary cortex and the cork, which have almost attained their final development.

The Rhizome.—The young stolon drawn in figure 3 (St.) shows the structure as follows. The outer cell-wall of epidermis is thick, and covered with a thin, smooth cuticle; the cortex is homogeneous, and consists of c. 14 compact strata of thinwalled parenchyma without deposits of starch or crystals. There is no endodermis, and no distinct, continuous pericycle either, but a band of isolated strands of stereome (St. in figs. 7 and 8) of a few, two or three strata. Inside this band of stereids a meristematic tissue forms a closed, continuous band giving rise to a beginning formation of cork towards the periphery, while inwards a broad zone of thinwalled, compact parenchyma has become developed, a secondary cortex of 15-20 layers, rich in starch, and in the periphery of which secondary

strands of stereome are developed, corresponding with the primary, but yet very thinwalled (St.* in Fig. 7 and 8); these secondary strands of stereome extend through the secondary cortex to the leptome, as very narrow rays, the stereids themselves being more or less compressed radially. Bsides these strands, which are situated in the same radii as the primary stereome there are also some very young strands visible between these (St.* in Figure 8) which thus indicate the final development of a larger number of stereomatic rays from the leptome towards the phellogen. Regarding the stele in the stolon the hadromatic rays are relatively short with no indication of libriform (Fig. 9). The pith represents a broad parenchyma of thinwalled cells with a little starch in small grains.

While thus the peripheral tissues from the epidermis to the cork are well preserved in the young stolon, we notice in the older rhizome only the cork as a broad zone, and thinwalled as before. The secondary stereome now represents many radiating strands, and is very thick-walled. The secondary cortex shows the same structure as before, but contains also some aggregated crystals of calcium-oxalate. The mestome represents a compact stele with deep rays of hadrome with wide vessels and much thickwalled libriform; in the center of the stele is a compact, thinwalled pith with a little starch of small grains.

The Aerial Stem.—From base to apex we find the same tissues, and arranged in exactly the same manner as in the subterranean rhizome, with the difference, however, that the secondary tissues are absent, of course, from the stem-part, which does not last for more than one season; the species being suffrutescent only the basal internodes persist and remain active for several years. In beginning with the basal internodes, the peripheral tissues are intact although increase in thickness has taken place, resulting in the development of cork, secondary stereome, and secondary cortex. The cuticle is thick, smooth, and the outer cell-wall of the epidermis is very thick; the cortex consists of c. 8 strata of thinwalled cells, containing cholorophyll, but no crystals; it is somewhat collapsed here and there on account of the increase in thickness of the inner tissues. Fourteen separate strands of thick-

walled stereome form a band, surrounding a broad zone of thinwalled cork; then follows a broad parenchyma, the secondary cortex, containing large, aggregated crystals besides deposits of starch, and in the periphery of this parenchyma we notice small stereomatic strands in the same radii as the former, the primary stereome. With respect to the stele the hadrome forms deep rays, and thick-walled libriform is well represented. The central portion of the stele is represented by a broad pith, thinwalled, but solid, and containing starch of fine grains in the peripheral layers, but no crystals.

A more simple structure characterizes the upper internodes, in which no increase in thickness takes place. The surface of these internodes is not smooth as is the case of the basal, but shows longitudinal crests, very low, but well marked, and these correspond with the stereomatic strands in the cortex. The cuticle and the epidermis show the same structure as in the basal internodes; the cortex consists of c. 6 chlorophyll-bearing layers between the strands of stereome, and of only two outside these. The number of stereomatic strands is fourteen, and they are located just outside the fourteen collateral mestome-strands, which constitute the stele, and of which the hadrome shows many wide vessels, and much thick-walled libriform; the hadrome is in the form of the letter V (in cross-sections) with the point extending deeply into the pith. Between these primary mestome-strands the interfascicular cambium has given rise to small strands of leptome and a few vessels. The pith shows the same structure as in the basal internodes, but contains no starch. So far as concerns the endodermis and the pericycle, none of these tissues were observed in these internodes, the latter at least nowhere as a closed sheath.

Characteristic of the stem-structure, the subterranean as well as the aerial, of *Comandra umbellata* is thus: the deep location of the phellogen i. e. inside the primary stereome-strands; the development of secondary stereome corresponding with the primary, and the constantly identical structure of all the internodes of the rhizome, its branches, the basal internodes of the aerial stems, in short of all the persisting parts

of the stem, recurring in the superior internodes with the only exclusion of the secondary tissues.

The Leaf.—The leaves are held in an erect position, and so far as concerns the chlorenchyma, the structure is approximately centric. The cuticle is thin, and smooth, and the epidermis shows the outer wall slightly thickened on both faces of the blade; viewed in superficial sections the lateral cell-walls are straight, nowhere undulate; the stomata are surrounded by four ordinary epidermal cells, and they are confined to the dorsal face of the leaf-blade; no hairs were observed. The chlorenchyma represents an almost homogeneous chlorophyll-bearing tissue of more or less isodiametrical cells, interspersed here and there with some few, short palisade-cells; no part of the chlorenchyma shows the structure characteristic of a pneumatic tissue. The midrib contains a single mestome-strand, with a large group of thinwalled stereome on the leptome-side, and embedded in a small water-storage tissue, becoming slightly collenchymatic in the keel; the lateral veins are embedded in the chlorenchyma, and lack stereome and water-storage tissue; they are terminated by thickwalled, porose tracheids, generally in groups of two to five cells, the function of which is to store water. In some of the other genera, *Thesium*, *Quinchamalium* and *Myzodendron*, similar systems of tracheids occur, but these are totally independent of the mestome-strands of the veins; they traverse the chlorenchyma in various directions, and are especially characteristic of *Santalaceae*, *Loranthaceae*, *Loasaceae* and *Olacineae*.

According to Solereder the development of cork is always superficial in the *Santalaceae*, but as shown in the preceding pages, *Comandra umbellata* forms an exception; furthermore, when the development of secondarry stereome is only recorded from *Santalum* and *Omphacomeria*, we have seen that this occurs also in *Comandra*. The statements by Solereder are based upon Behm's treatment of the anatomy of *Santalaceae*, and this author describes *Comandra* as destitute of stereome, and makes no mention of the cork. Several other points differ from our observations, and it seems safe to conclude, that the material examined by Behm was not correctly identified.

Moreover Chatin has, many years ago, demonstrated the presence of primary stereome in *Comandra livida*.

In bringing these facts together we have in *Comandra umbellata* a remarkable type of a "terrestrial parasite," as the genus is always described to represent. But, when we consider the habit and structure of the mature plant, it would hardly seem probable that such old specimens are parasitic. The development of a large rhizome, and the profuse vegetative reproduction, altogether, does not point towards a parasitic habit, even if some of the roots are provided with haustoria. It seems more likely, we believe, that *Commandra* is only parasitic at the young stages of its development, and perhaps only in the first year, when a seedling, as is the case of so many of the herbaceous, terrestrial and green parasites of some of the other families, and notably the *Scrophulariaceae*.

BIBLIOGRAPHY.

Baillon, H. Traité du dèveloppement de la fleur et du fruit. Adansonia IX, 1869.

Behm, M. Beiträge zur anatomischen Charakteristik der Santalaceen. Botan. Centralbl. Vol. 62, 1895, p. 65.

De Candolle, Alph. Note sur la famille des Santalacées. Bibliothèque univers. de Genève. 1857.

Eicher, A. W. Blüthendiagramme. Leipzig 1878. Part II. p. 537.

Fernald, M. L. An undescribed northern *Comandra*. Rhodora. Vol 7. Boston, 1905. p. 47.

Heller, A. A. Botanical exploration in California. Season of 1905. Muhlenbergia Vol. 2 No. 1 (*Comandra Californica* Eastw. ined.)

Hooker, W. J. Flora Boreali-Americana. Vol. 2. London, 1840. p. 138.

Planchon et Decaisne in Bull. de la soc. Bot. de France. Vol. 2. Paris, 1855. p. 86. (Communication.)

Reichenbach, L. Icones Florae Germanicae et Helveticae. Vol. XI. Leipzig, 1849. Tab. 547.

Solereder, H. Systematische Anatomie der Dicotyledonen. Stuttgart, 1899, p. 823.

Van Tieghem, Ph. Anatomie de la fleur des Santalacées. Ann. d. sc. nat. Bot. Ser. V. Tome 12. Paris, 1869, p. 340.

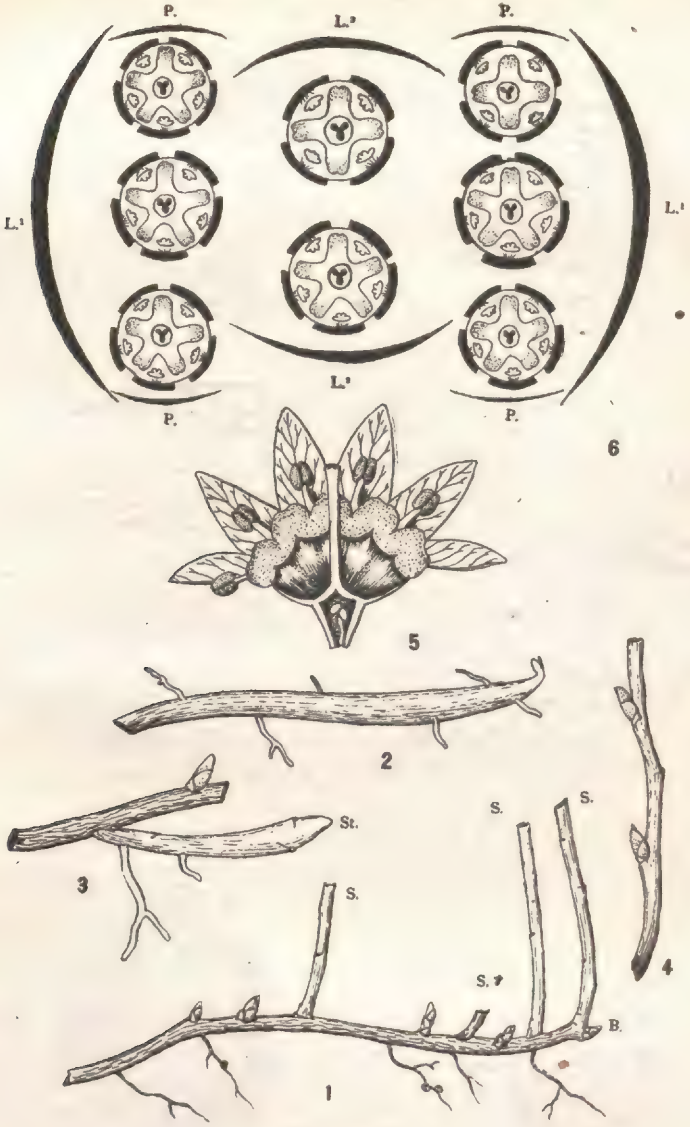
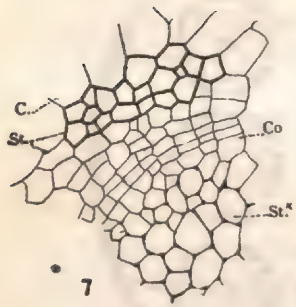


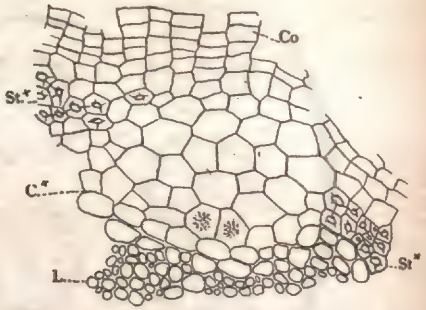
PLATE I.

EXPLANATION OF FIGURES.

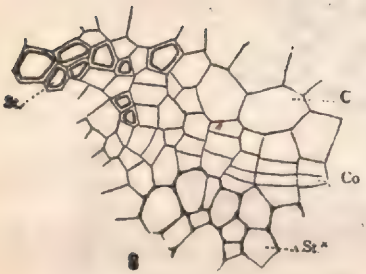
Comandra umbellata.



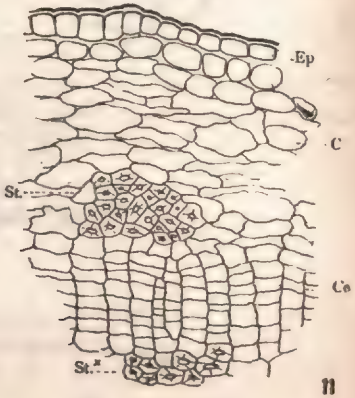
7



10

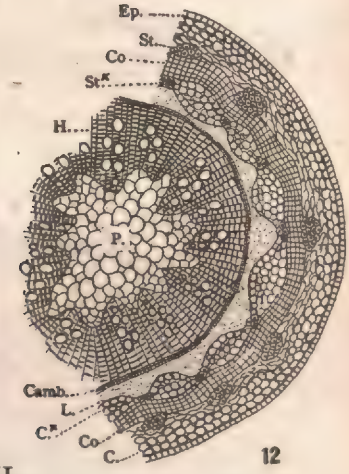


8



11

9



12

PLATE II.

Figure 1. A mature rhizome, collected in September, 1923. B—the terminal bud; S—three flowering shoots of 1923; S*—base of a withered shoot of 1922; natural size.

Figure 2. Apex of a rhizome with the terminal bud, collected in June, 1923; 1 2-3 x natural size.

Figure 3. Part of a rhizome with a subterranean branch St., and a bud, which will develop an aerial shoot next year; 1 2-3 x natural size.

Figure 4. A basal internode of an aerial shoot with buds to winter over; collected in September; 1 2-3 x natural size.

Figure 5. A flower, laid open; enlarged.

Figure 6. Diagram of an inflorescence; L^1 and L^2 the bracts; P—the prophylla; for explanation see the text.

Figure 7. Cross-section of a young stolon, collected in October; C—primary cortex; St.—primary stereome; Co.—cork; St.*—secondary, young stereome; x 240.

Figure 8. Cross-section of the young stolon, showing a strand of secondary young stereome (St.*) between two strands of primary stereome (St.), of which only one has been drawn; Co.—cork; x 320.

Figure 9. Cross-section of a mestome-strand from the stolon; L—leptome; Camb.—cambium; H—hadrome; P—pith; x 320.

Figure 10. Cross-section of a basal internode of a flower-bearing stem; C*—secondary cortex; the other letters as above; x 320.

Figure 11. Cross-section of same internode; Ep.—epidermis; C.—primary cortex; other letters as above; x320.

Figure 12.—Cross-section of same internode, showing the arrangement of all the tissues from the epidermis to the central pith; letters as above; x 60.

Clinton, Md., November, 1923.

Some Effects of the First Fall Freeze.

O. A. STEVENS.

A tabulation of the degree to which different species of plants are injured by the first freezing temperature of autumn has seemed of interest. The past year was quite favorable to such observations, the first frost of the season on September 13 being accompanied by a minimum temperature of 27 degrees F. (Weather Bureau station at Moorhead, Minnesota.) Most of these observations were made two days later at Fargo, North Dakota. The following symbols are used to designate the condition of the plants. Those unmarked appeared to be uninjured:

1. Slightly injured; a few leaves killed.
2. About half of the leaves killed.
3. Entirely killed.
* In flower.
** Flowering after the freeze.

Many of the plants named would not be expected to show injury but the list will show the extent of the observations. Some common cultivated plants indicate the severity of the freeze. Sweet corn, tomato, cucurbits, zinnia, cosmos, entirely killed; beet, cauliflower, leaves partly killed; celery, parsnip, carrot, cabbage, sweet pea, uninjured.

Sagittaria arifolia 2-3
Digitaria humifusa 3
Panicum capillare 2
Echinochloa crusgalli 3
Chaetochloa viridis 3
Homalocenchrus oryzoides
Poa pratensis
Bromus inermis
Agropyron repens
Hordeum jubatum
Elymus virginicus
Cyperus esculentus
Arisaema triphyllum 2
Vagnera stellata 3
Salomonia commutata
Smilax herbacea
Juglans nigra (introduced) 3
Celtis occidentalis (small trees)
Urtica gracilis
Urticastrum divaricatum 3 (or nearly)
Rumex salicifolius
Rumex persicarioides
*Polygonum aviculare
*Polygonum erectum
Polygonum lapathifolium 2
Polygonum pennsylvanicum 2
Polygonum emersum

Polygonum convolvulus	2-3	**Malva borealis	
*Chenopodium album	2-3	Viola pubescens	
Chenopodium hybridum	1	*Viola rugulosa	
Atriplex patula		Washingtonia longistylis	
Amaranthus retroflexus	3	Zizia aurea	
Amaranthus graecizans	3	Deringia canadensis	
Amaranthus blitoides	3	Heracleum lanatum	
**Alsine media		Cornus femina	
Silene noctiflora.		Steironema ciliatum	
Portulaca oleracea	2-3	Fraxinus lanceolata (small trees)	2-3
Ranunculus abortivus			
**Oxygraphis cymbalaria		Apocynum hypericifolium	
Thalictrum dasycarpum		Asclepias syriaca	3
Anemone canadensis		*Cuscuta gronovii	3
Clematis virginiana		Convolvulus sepium	3
Menispermum canadense		Hydrophyllum virginicum	
**Thlaspi arvense		Physostegia parviflora	
*Lepidium apetalum		*Stachys palustris	
**Bursa bursa-pastoris		*Mentha canadensis	
**Brassica arvensis		Catalpa speciosa (introduced)	2
*Sisymbrium altissimum	1	Plantago major	
**Erucastrum pollichii		Plantago rugelii	
**Erysimum chieranthoides		Galium triflorum (?) (seedlings)	
Radicula palustris		Symphoricarpos occidentalis	
Ribes americanum		Micrampelis lobata (see notes)	
Ribes gracile		Ambrosia trifida	1-2
Rubus strigosus		Ambrosia artemisiaefolia	
Agrimonia striata		Iva xanthiifolia	
Rosa arkansana		Xanthium canadense	1-2
Prunus virginiana		**Grindelia squarrosa	
Trifolium pratense	1	Solidago canadensis	
*Trifolium repens		Solidago serotina	
**Melilotus alba		Boltonia asteroides	
**Melilotus officinalis		**Aster laevis	
Medicago sativa	1	*Aster paniculatus	
Glycyrrhiza lepidota		**Aster multiflorus	
Falcata comosa	2	**Leptilon canadense	1
**Oxalis stricta		*Rudbeckia lacinata	
Euphorbia esula		Solidago serotina	
Euphorbia serpyllifolia	2-3	Helianthus maximiliani	
Rhus radicans		Helianthus tuberosus	
Acer negundo (small trees)	1-2	*Bidens frondosa	
Vitis vulpina	2	*Bidens acuta	
Parthenocissus quinquefolia	2	*Bidens cernua	
Tilia americana (small trees)		*Artemisia biennis	
Hibiscus trionum	3	*Artemisia caudata	

*Artemisia gnaphalodes		*Sonchus oleraceus	2
Artemisia frigida		*Sonchus asper	2
Arctium minor		*Lactuca scariola	3
Carduus undulatus		Lactuca ludoviciana	3?
Carduus arvensis		*Lactuca spicata	
**Taraxacum officinale		Lactuca pulchella	
*Sonchus arvensis	2		

About half of the species were noted in the open, the others in the woods and along the riverbank. Some differences were observed in the plants of the same species growing under different conditions, but it has seemed hardly worth while to keep the two lists separate. At one place in the woods Urticastrum, Falcata and Hydrophyllum were noted growing close together and showing distinctly the 3, 2 and 0 conditions of injury. At another place the Urticastrum was not entirely killed although better protection was not evident. A branch of Micrampelis running across a narrow bar by the river's edge seemed quite untouched, but plants on bushes in a low place between a bank and the other edge of the woods were entirely killed. Echinochloa and Panicum capillare on the bar were killed.

In general, basal leaves were little affected even where stem leaves were entirely killed. Sonchus spp. showed such a condition. Lactuca scariola was entirely killed as to leafy stems, but the leaves of seedlings remanied fresh and green. Occasional plants of Sonchus oleraceus and S. asper were observed in flower among houses of the city some time after the frost. One plant of Lactuca scariola was observed thus, but it may not have flowered previous to the frost. A few fresh plants of Chaetochloa viridis also were seen in such a position. Some species, notably Chenopodium album, appeared little affected on the date that the notes were taken, but a little later unprotected plants were observed to be mostly dead.

In addition to Thlaspi, Alsine, Taraxacum and Brassica, Malva borealis was one of the notably hardy plants, growing vigorously and continuing to flower. After several other light freezes, temperatures of 13 degrees and 14 degrees occurred at the end of October. Following this most of the leaves of Taraxacum, Brassica, Melilotus, and Malva were dead. Small

plants of Thlaspi, some Alsine and the winter annual rosettes of Lactuca scariola were still quite fresh and green. Half or more of the leaves were killed on parsnips, celery and red clover.

The plants in the list may be divided into several groups as follows:

1. Introduced plants continuing to flower until frost—Chaetochloa, Digitaria, Panicum capillare, Echinochloa, Amaranthus, Polygonum spp., Hibiscus, Lactuca scariola, Sonchus.
2. Tender natives—Sagittaria, Arisaema, Asclepias, Cuscuta, Convolvulus.
3. Partly tender natives—Falcata, Euphorbia, Acer negundo, Vitis, Parthenocissus, Fraxinus, Micrampelis, Ambrosia trifida, Xanthium.
4. Plants which have completed flowering and growth; leaves apparently little injured, but leaf fall probably hastened by frost—Vagnera, Salomonia, Smilax, Rumex, Clematis and many others.
5. Plants which have flowered earlier but retain more or less hardy basal foliage—Ranunculus abortivus, Anemone canadensis, Viola, Washingtonia, etc.
6. Late flowering, hardy plants—Solidago, Aster, etc.
7. Hardy plants flowering throughout season, and frequently after frost—Alsine, Oxygraphis, Cruciferae, Melilotus, Oxalis, Malva, Taraxacum.
8. Winter annuals and biennials (seedlings)—Cruciferae, Arctium, Lactuca scariola, Artemisia caudata.

North Dakota Agricultural College.

The Naiad-Fauna of Duck River in Tennessee.

BY DR. A. E. ORTMANN.

Duck River in central Tennessee is one of the most important tributaries of the Tennessee River. It has the peculiarity of running in an east-westerly direction, and joining the Tennessee in that part of its course, which is directed across the state from South to North, while other tributaries of this region run essentially in a southerly or southwesterly direction, flowing into Alabama and uniting with the master stream at, and for some distance above, the Mussel Shoals.

The sources of Duck River are in the part of the Cumberland Plateau (in its widest sense), called the *Highland Rim*, at an elevation of about 1200 feet (see U. S. Topogr. Atlas sheet Hollow Springs), that is to say rather low as compared with other streams of this region. The Highland Rim consists largely of Lower Carboniferous siliceous limestones (Mississippian). Flowing then, in the main, in a direction somewhat north of west, it traverses in a valley of entrenched meanders the *Nashville Dome* (or the interior basin of Central Tennessee), consisting of Middle and Upper Ordovician rocks, reaching, between Columbia and Centreville, again the Mississippian Highland Rim of the western flank of the dome, and continuing in it to its junction with the Tennessee.

The greatest part of its drainage is in this central basin, only *Buffalo River*, its largest tributary, is entirely in the western portion of the Highland Rim. I visited the latter only on its headwaters. Of other tributaries, I am acquainted with *Big Bigby Creek* and *Rutherford Creek* in Maury Co.; with *Rock Creek* in Marshall Co.; *Garrison Creek* and *Thompson Creek* in Bedford Co. (all these in the interior basin); and *Little Duck River*, Coffee Co. (eastern part of Highland Rim); but I found Naiades only in *Buffalo River* and *Garrison Creek*.

In the main river, however, Naiades are abundant, and I collected at eleven stations, from Centreville to Manchester,

mostly with great success. Duck River is in very good condition, no pollution entering it, except in the region between Columbia and Centreville, where Phosphate mines send muddy water to it; but the amount of pollution is small, and its character obscure, and only at Centreville some indication of an injurious effect was noticed. For the rest, Naiad-life was plentiful, the gravel bars were covered with large numbers of dead shells, and the living ones were found at the proper places in abundance, often closely crowded together. Of course, towards the headwaters, the number of species and individuals decreases, and at Manchester there was only one species in small numbers.

Duck River being located between Cumberland River in Kentucky and Tennessee, and Tennessee River in northern Alabama, might be expected to contain a similar fauna to these two systems, a fauna which is known to contain peculiar elements, not found outside of this region in the Central Basin (Mississippi and Ohio drainages), which might be called "Cumberlandian" types (from the "Cumberland subregion").* And indeed, some of them are present. But I have found that there are other constituents in this fauna, and in view of our poor knowledge of the Naiad-fauna of the Cumberland subregion, chiefly of the exact distributional facts of the various forms, I thought it might be desirable, to connect the present study with an investigation of the zoögeographical affinities of Duck River. The material thus presented will be useful for a subsequent general study of the history of the Cumberland Naiad-fauna, the fauna of the Cumberland and Tennessee Rivers. †

Our previous knowledge of the Naiades of Duck River is very unsatisfactory. Lea, in his publications collected in "Observations on the Genus Unio," mentions four species: *U. big-*

* More about these will be found toward the end of this paper.

† The principal papers published more recently, which treat of this fauna, and are largely cited in the following pages, are the following: Wilson, C. B. and Clark, H. W. The Mussels of the Cumberland River and its Tributaries (Bur. of Fisher. Doc. 781. 1914. 63 pp.). Ortmann, A. E. The Naiades of the Upper Tennessee Drainage, Etc. (Proc. Amer. Philos. Soc. 57. 1918. pp. 521-626).

byensis Lea '41 (Obs. 3. '42) from Big Bigby Creek, Maury Co.; *U. clarkianus* Lea '52 (Obs. 5, '52) from Williamsport, Maury Co.; *U. cylindrellus* Lea '68 (Obs. 12, '69); and *U. validus* Lea '71 (Obs. 13, '74), both from "Duck River, Tenn." Of these, *U. clarkianus* (Lampsilis clarkiana) should be canceled (already questioned by Simpson), the locality apparently being erroneous, this shell belonging to the headwaters of the Alabama drainage. The other three species stand now as *Fusconaia barnesiana bigbyensis, Carnuculina cylindrella,* and *Fusconala barnesiana,* their presence in Duck River being confirmed by my observations.

In 1885, Hinkley and Marsh * published a list of Naiades from central Tennessee. Unfortunately, the identifications are not all reliable, and in several cases it remains doubtful, which species were intended. A number of these shells came from Duck River at Columbia, Maury Co., Tenn., and it has been possible to recognize many of them according to my own collections made at Columbia and in Duck River in general. They are the following, arranged according to the modern system and the modern nomenclature:

1. *Fusconaia barnesiana* (as *U. barnesianus* and *validus*)
2. *Megalonaias gigantea* (as *multiplicatus*)
3. *Amblema costata* (as *undulatus*)
4. *Quadrula pustulosa*
5. *Quadrula fragosa*
6. *Quadrula verrucosa* (as *tuberculatus*)
7. *Quadrula intermedia*
8. *Quadrula cylindrica*
9. *Cyclonaias tuberculata* (as *verrucosus*)
10. *Lexingtonia dolabelloides* (as *circumactus*)
11. *Pleurobema cordatum pyramidatum*
12. *Pleurobema oviforme* (as *clinchensis, lesleyi patulus*)
13. *Pleurobema oviforme holstonense* (as *pattinoides*).
14. *Eiliptio crassidens* (as *gibber*)
15. *Eiliptio dilatatus* (as *gibbosus*)
16. *Lastena lata* (as *dehiscens*)
17. *Lasmigona costata* (as *rugosa*)
18. *Strophitus rugosus* (as *schafferiana*)

* Hinkley, A. A. and Marsh, P. List of Shells Collected in Central Tennessee (Aledo, Ill. July, 1885). This paper has been overlooked by Simpson in the bibliography published in his "Synopsis" (1900). My attention has been called to it by C. Goodrich, Toledo, who also kindly loaned me his copy of it.

19. *Ptychobranchus fasciolare* (as *camelus*)
20. *Ptychobranchus subtentum*
21. *Obliquaria reflexa* (as *cornutus*)
22. *Cyprogenia irrorata*
23. *Obovaria retusa*
24. *Obovaria subrotunda* (as *circulus*)
25. *Actionaias pectorosa* (as *perdix*)
26. *Plagiola lineolata* (as *securis*)
27. *Truncilla truncata* (as *elegans*)
28. *Truncilla donaciformis*
29. *Leptodea leptodon* (as *tenuissimus*)
30. *Leptodea fragilis* (as *gracilis*)
31. *Carunculina cylindrella*
32. *Conradilla caelata*
33. *Medionidus conradicus*
34. *Micromya fabalis*
35. *Ligumia recta latissima* (as *rectus*)
36. *Lampsilis ovata*
37. *Lampsilis fasciola* (as *perradiatus*)
38. *Dysnomia triquetra* (as *triangularis*)
39. *Dysnomia brevidens*
40. *Dysnomia lenior*
41. *Dysnomia turgidula* (as *deviatus* and *turgidulus*)
42. *Dysnomia florentina*

In addition the following are in the list, but probably misidentified:

U. hartmanianus Lea. (*Pleurobema h.*) A Coosa River form, surely not present in Duck River. But it is impossible to say, what it stands for.

U. phillipsi Conrad. A species altogether doubtful; it may be an abnormal *Obliquaria reflexa.*

U. nashvillensis Lea. This is *Ligumia subrostrata,* a species very likely not found in Duck River, since the required ecological conditions are missing. It is possible that gigantic specimens of *Micromya vanuxemensis* (such as found by myself) have been taken for it.

Of the above 42 species I have been able to confirm the existence, in Duck River, of all except the following (7): *Elliptio crassidens, Cyprogenia irrorata, Obovaria retusa, Plagiola lineolata, Leptodea leptodon, Ligumia recta latissima. Dysnomia lenior.* Since they are all rather striking forms, not easily to be mistaken, they should be credited to Duck River, and will be enumerated below.

Three of the species given by Hinkley and Marsh are given also by Call * for Duck River: *U. clinchensis* (equals) *Pleurobema oviforme; U. multiradiatus* (equals) *U. perradiatus* (of Hinkley & Marsh) (equals) *Lapsilis fasciola;* and *U. turgidu-*

* Call, R. E. Geographical Catalogue of the Unionidae of the Mississippi Valley (Bull. Des Moines Acad. Sci. 1. 1885, pp. 1-57.)

lus (equals) *Dysnomia turg.;* and in subsequent paper*) he adds another one: *U. clavus*, but as will be shown below this is not the real *Pieurobema clava* (Lamarck), but should also be placed with *Pleurobema oviforme* (Conrad).

In the same year (1895), Marshall † gave incidentally a number of records for shells from Duck River (all connected with the name of Hinkley). There are 8 of them: *U. crassidens* (now: *Elliptio cr.*); *U. elegans* (now: *Truncilla truncata*); *U. fabalis*, (now: *Micromya f.*); *M. marginata* (now *Alasmidonta m.*); *U. multiradiatus* (now: *Lampsilis fasciola*); *M. rugosa* (now: *Lasmigona costata*); *U. triangularis* (now: *Dysnomia triquetra*); *U. undulatus* (now: *Amblema costata*). All are found in the list of Hinkley and Marsh, with exception of *Alasmidonta marginata.* It is interesting, that here *Elliptio crassidens* is given by its correct specific name (not as *gibber*).

Among older material, represented in the Carnegie Museum, the following forms from Duck River are found:

Megalonaias gigantea. Duck R. (Sterki collection).
Cyclonaias tuberculata, Duck R. (Sterki collection.)
Pleurobema cordatum catillus, Columbia. (Walker don.)
Pleurobema cordatum catillus, Columbia. (Walker don.).
Actinonaias pectorosa. Duck R. and Columbia (Hartman collection and Walker don.).
Conradilla caelata, Hickman Co. (Hartman collection.)
Dysnomia triquetra, Columbia (Clapp don.).
Dysnomia florentina walkeri, Duck R. (Sterki collection.)
Dysnomia capsaeformis. Columbia (Sterki collection).

Of these, *Pleurobema cordatum* and *cord. catillus,* and *Dysnomia capsaeformis* are new for this system, while *Dysnomia florentina walkeri* undoubtedly corresponds to *D. florentina*

I visited the river in 1921, 1922, and 1923, and obtained altogether 11 stations for Naiades in the main river, and two

* Call. R. E. A Study of the Unionidae of Arkansas, etc. Trans. Acad. St. Louis 7. 1895, pp. 1-64).

† Marshall, W. B. Geographical Distribution of the New York Unionidae (48. Ann. Rep. N. Y. State Mus. (1894) 1895, pp. 47-99). (in the list of Hinkley and Marsh), and originally was so labelled.

in tributaries. The following list contains a short description of these localities, with the Naiades found at each of them:

Duck River, Centreville, Hickman Co., Tenn. (Aug. 29, Sept. 3 and 4, '21):

Riffles from below R. R. bridge to above wagon bridge, and quiet pool above the latter, distance of a little over a mile.

Water low and clear, so that conditions were favorable. Many dead shells were seen on the gravel bars and in the water, but living shells were scarce. Altogether this place had the appearance as if the Naiades had been partially killed off at some time, and that the fauna had not yet recovered. The living shells generally were old (yet a few young *Praptera alata* were found), and the number of species is comparatively small.

Between Columbia and Centreville, chiefly to the south of the river, are extensive phosphate mines, from which, at times, very muddy water reaches the river. But I cannot imagine what injurious substances it contains. There are or were also iron mines in the vicinity. But the fact is evident that normal conditions for Naiad life do not prevail here. It should be noted, on the other hand, that the *Pleurocerid*-fauna * of this place was extremely plentiful and rich in forms. The Naiades ascertained to exist here are the following:

1. *Megalonaias gigantea*
2. *Amblema costata*
3. *Quadrula pustulosa*
4. *Quadrula quadrula*
5. *Quadrula verrucosa*
6. *Cyclonaias tuberculata* (seen only)
7. *Lasmigona complanta*
8. *Ptychobranchus fasciolare*
9. *Obilquaria reflexa*
10. *Truncilla donaciformis*
11. *Leptodea fragilis*
12. *Proptera alata*
13. *Lampsilis anodontoides*

Only Nos. 1, 2, 3, 5, 11, and 12 of these were found living.

Duck River, Ben. Maury Co., Tenn. (Sept. 2, '23):

A small place of this name is located about one and a half mile west of the river, near the lower end of "Alexander Bend" (on Topogr. Atlas Sheet Columbia). Along the river, this is about 7 miles below Columbia.

---

* Partially reported upon by Goodrich, Nautilus, 35. Octob. '21, p. 58-59.

A large gravel bar at the lower end of a quiet pool obstructs the river. At highwater there are two branches, but the smaller (left) does not contain water at low stage. At the time of my visit the water was muddy, so that no living shells could be seen; but they were found in good numbers by feeling for them in the larger (right) branch, where the quiet water of the pool begins to rush down, past the gravel bar. The river apparently was not at the lowest stage, so that specimens (and probably additional species) in the deeper water of the channel (three or more feet) could not be obtained. All forms were alive, except those marked.

1. *Ambiema costata*
2. *Quadrula pustulosa*
3. *Quadrula verrucosa*
4. *Quadrula cylindrica*
5. *Cyclonaias tuberculata*
6. *Lexingtonia dolabelloides*
7. *Lexingtonia dolabelloides conradi.*
8. *Pleurobema cordatum catillus*
9. *Pleurobema oviforme holstonense*
10. *Elliptio dilatatus*
11. *Lasmigona costata*
12. *Lasmigona complanata*
13. *Strophitus rugosus* (dead)
14. *Ptychobranchus fasciolare* (dead)
15. *Obovaria subrotunda lens*
16. *Actinonaias carinata*
17. *Actinonaias pectorosa*
18. *Proptera alata* (seen only, dead)
19. *Lampsilis ovata*

Duck River, Columbia, Maury Co., Tenn. (Aug. 26 and Sept. 1, '21, and Sept. 6, '22):

I collected about two miles below the town of Columbia, immediately above the mouth of Rutherford Creek. By a gravel bar, the river is divided into two branches, above this is a quiet pool. The shells were in the larger, deeper, left branch, in a similar situation to that at Ben. At my three visits, the condition of the river was about the same, with the water at low stage, but somewhat muddy. Many shells, in a few inches of water, were seen, but the majority was found by feeling for them. The locality was not only rich in species, but also in individuals, the latter crowding close together in the gravel. Most of the species were found alive, except those marked.

1. *Fusconaia barnesiana*
2. *Megalonaias gigantea*
3. *Amblema costata*
4. *Quadrula pustulosa*
5. *Quadrula verrucosa*
6. *Quadrula intermedia* (dead)
7. *Quadrula cylindrica* (dead)
8. *Cyclonaias tuberculata*

9. *Lexingtonia dolabelloides*
10. *Lexingtonia dolabelloides conradi*
11. *Pleurobema cordatum*
13. *Pleurobema cordatum pyramidatum*
14. *Pleurobema oviforme*
15. *Pleurobema oviforme holstonense*
16. *Elliptio dilatatus*
17. *Lastena lata*
18. *Lasmigona costata*
19. *Lasmigona complanata*
20. *Alasmidonta marginata* (seen only, dead)
21. *Strophitus rugosus*
22. *Ptychobranchus fasciolare*
23. *Ptychobranchus subtentum*
24. *Obovaria subrotunda*
25. *Obovaria subrotunda lens*
26. *Actinonaias carinata*
27. *Actinonaias pectorosa*
28. *Trnucilla truncata*
29. *Leptodea fragillis*
30. *Proptera alata* (seen only, dead)
31. *Conradilla caelata*
32. *Medionidus conradicus* (dead)
33. *Lampsilis ovata*
34. *Lampsilis ovata ventricosa*
35. *Lampsilis fasciola*
cf. *Dysnomia triquetra*
37. *Dysnomia brevidens*
38. *Dysnomia capsaeformis*

Duck River, four miles east of and above Columbia, Maury Co., Tenn. (Sept. 5, '22) :

This is at the extremity of a big meander of the river, below a covered bridge and an old dam, gone into decay. The water rushes fall-like through a gap in the dam. Immediately below, on the left bank, is a large gravel bar, covered with numbers of dead shells. Below this bar the water is more quiet, forming an eddy with mud-covered gravel. Here I found some living shells, in a depth of 2 to 3 feet, by feeling for them. The water was rather muddy, but near low-water stage. Most of the shells were gathered dead from the gravel bar, only *Amblema costata* and *Cyclonaias tuberculata* were found alive.

1. *Megalonaias gigantea*
2. *Amblema costata*
3. *Quadrula pustulosa*
4. *Quadrula fragosa*
5. *Quadrula verrucosa*
6. *Cyclonaias tuberculata*
7. *Elliptio dilatatus* (seen only)
8. *Lasmigona costata*
9. *Lasmigona complanata*
10. *Alasmidonta marginata*
11. *Ptychobranchus fasciolare*
12. *Obovaria subrotnuda lens* (seen only)
13. *Actinonaias pectorosa*
14. *Lampsilis ovata ventricosa*
15. *Dysnomia triquetra* (seen only)

Duck River, Leftwich, Maury Co., Tenn. (Sept. 3, '23) :

Below Leftwich Bridge is a bush-covered island or islands, dividing the river into several branches. I selected the left

one, which is narrow, rocky and gravelly, rather deep in places, but with a number of shallower riffles. The stage of the water was fairly low, but the water was muddy, just beginning to clear. No shells were found by sight, all by feeling, mostly in a swiftly flowing portion in one to two feet of water, on gravelly bottom. All were alive.

1. *Amblema costata*
2. *Quadrula pustulosa*
3. *Quadrula verrucosa*
4. *Cyclonaias tuberculata*
5. *Lexingtonia dolabelloides conradi*
6. *Pleurobema cordatum catillus*
7. *Pleurobema cordatum pyramidatum*
8. *Elliptio dilatatus*
9. *Lasmigona costata*
10. *Alasmidonta marginata*
11. *Ptychobranchus subtentum*
12. *Obovaria subrotunda lens*
13. *Conradilla caelata*
14. *Medionidus conradicus*
15. *Lampsilis ovata*
16. *Lampsilis fasciola*
17. *Dysnomia triquetra*
18. *Dysnomia capsaeformis*

Duck River, Lillard's Mills, Marshall Co., Tenn. (Aug. 25, '23):

This is below an old dam. The river is broad, forming a ford. The water was beginning to clear, and was nearly at low stage. For about two-thirds of the width of the river (from left bank), the water was very shallow, and some living shells were visible here. A gradually deepening channel was close to the right bank, in part densely overgrown with water weeds. Among these weed patches, on gravelly-sandy bottom, the majority of the Naiades was found by feeling for them. Current lively, in part strong. All species were found alive.

1. *Amblema costata*
2. *Quadrula fragosa*
3. *Quadrula verrucosa*
3. *Quadrula cylindrica*
5. *Cyclonaias tuberculata*
6. *Lexingtonia dolabelloides conradi*
7. *Pleurobema cordatum pyramidatum*
8. *Pleurobema oviforme*
9. *Elliptio dilatatus*
10. *Lasmigona costata*
11. *Alasmidonta marginata*
12. *Strophitus rugosus*
13. *Obovaria subrotunda lens*
14. *Actionaias pectorosa*
15. *Leptodea fragilis*
16. *Medionidus conradicus*
17. *Lampsilis ovata ventricosa*
18. *Lampsilis fasciola*
19. *Dysnomia florentina walkeri*
20. *Dysnomia capsaeformis*

Duck River, Wilhoite, Marshall Co., Tenn. (Aug. 27, '23):

Similar to the preceding place, below a dam. Water strongly, but irregularly, flowing, the shallower part on the right

bank, the deeper channel on the left. Plenty of water weeds. Conditions most favorable, water clear enough to see shells up to a depth of about eight to ten inches. The stage must have been low water, since many shells were found close to banks in a few inches of water. All species found alive.

1. *Fusconaia barnesiana*
2. *Fusconaia barnesiana bigbyensis*
3. *Amblema costata*
4. *Quadrula fragosa*
5. *Quadrula verrucosa*
6. *Quadrula cylindrica*
7. *Cyclonaias tuberculata*
8. *Lexingtonia dolabelloides conradi*
9. *Pleurobema cordatum catillus*
10. *Pleurobema cordatum pyramidatum*
11. *Pleurobema oviforme*
12. *Pleurobema oviforme argenteum*
13. *Elliptio dilatatus*
14. *Lasmigona costata*
15. *Strophitus rugosus*
16. *Obovaria subrotunda*
17. *Obovaria subrotunda lens*
18. *Carunculina moesta*
19. *Medionidus conradicus*
20. *Micromya fabalis*
21. *Lampsilis ovata*
22. *Lampsilis ovata ventricosa*
23. *Lampsilis fasciola*
24. *Dysnomia triquetra*
25. *Dysnomia brevidens*
26. *Dysnomia florentina walkeri*
27. *Dysnomia capsaeformis*

Duck River, Shelbyville, Bedford Co., Tenn. (Sept. 1 and 3, '22):

Also below a dam. River divided into a number of branches. In one of them, in and below a small riffle, in an eddy, with gravel and mud, the majority of the Naiades was found, in part by sight, in part by feeling for them. Water clear to a depth of about a foot, and apparently at low stage. Shells all found alive, with one exception, so marked.

1. *Fusconaia barnesiana*
2. *Fusconaia barnesiana bigbyensis*
3. *Amblema costata*
4. *Quadrula verrucosa*
5. *Cyclonaias tuberculata* (dead)
6. *Lasmigona costata*
7. *Anodonta grandis*
8. *Alasmidonta minor*
9. *Alasmidonta marginata*
10. *Strophitus rugosus*
11. *Obovaria subrotunda lens*
12. *Carunculina moesta*
13. *Medionidus conradicus*
14. *Micromya taeniata*
15. *Micromya vanuxemensis*
16. *Lampsilis ovata ventricosa*
17. *Dysnomia triquetra*
18. *Dysnomia turgidula*

Duck River, Normandy, Bedford Co., Tenn. (Aug. 22, '23):

A gravel bar, forcing the river to one (left) side. Water

strongly flowing, not very clear. Shells found by feeling, in gravel, and not very abundant. All alive.

1. *Fusconaia barnesiana*
2. *Fusconaia barnesiana bigbyensis*
3. *Alasmidonta minor*
4. *Strophitus rugosus*
5. *Ptychobranchus subtentum*
6. *Medionidus conradicus*
7. *Micromya taeniata*
8. *Micromya vanuxemensis*

Duck River, Coffee Co., Tenn. (Aug. 22, '23):

This is three miles east of Normandy. A ford, the river divided into several strongly flowing branches. Water not very clear. In a quiet eddy, in mud, a number of living specimens of *Carunculina cylindrella* were found. At another place, in a very small, strongly flowing connecting branch between two larger branches, two living specimens of *Lexingtonia dolabelloides conradi* were secured, both apparently washed out of deeper water.

Duck River, Manchester, Coffee Co., Tenn. (Aug. 21, '23):

Below bridge, northwest of town. Water, crystal-clear (a dam some distance above), flowing over solid bed-rock (honeycombed limestone). Under overhanging ledges of rock, in sand and mud, about half a dozen *Lasmigona holstonia* were found.

Buffalo River, Riverside, Lewis Co., Tenn. (Sept. 7, '22):

Close to, and below R. R. station. River only of creek-size, full of riffles and more quietly flowing water; water clear. Naiades abundant everywhere, on gravelly, sandy, and muddy bottom. All species found alive.

1. *Fusconaia barnesiana*
2. *Fusconaia barnesiana bigbyensis*
3. *Lexingtonia dolabelloides conradi*
4. *Pleurobema oviforme*
5. *Pleurobema oviforme argenteum*
6. *Lasmigona costata*
7. *Alasmidonta minor*
8. *Alasmidonta marginata*
9. *Strophitus rugosus*
10. *Ptychobranchus subtentum*
11. *Obovaria subrotunda lens*
12. *Actionaias pectorosa*
13. *Carunculina cylindrella*
14. *Micromya nebulosa*
15. *Micromya taeniata*
16. *Micromya vanuxemensis*
17. *Lampsilis ovata ventricosa*
18. *Lampsilis fasciola*

Garrison Creek, Wartrace, Bedford Co., Tenn. (Sept. 2, '22):

From R. R. bridge, south of town, one to two miles upward. Creek small, everywhere fordable, with great variety of conditions of current, bottom, etc. Shells chiefly at one place, in a riffle in very shallow water (a few inches deep), in gravel, not plentiful, but well visible in the clear water. All alive, except the one not taken.

1. *Fusconaia barnesiana*
2. *Fusconaia barnesiana bigbyensis*
3. *Lasmigona costata*
4. *Strophitus rugosus*
5. *Medionidus conradicus*
6. *Micromya vanuxemensis*
7. *Lampsilis ovata ventricosa* (seen only, dead)
8. *Lampsilis fasciola*

ENUMERATION OF FORMS WITH TAXONOMIC AND GEOGRAPHICAL REMARKS. *

1. *Fusconaia barnesiana* (Lea).

Duck R., Columbia, Wilhoite, Shelbyville, Normandy; Buffalo R., Riverside; Garrison Cr., Wartrace.—Previously reported from Columbia (as *U. validus* and *barnesianus*) (Hinkley and Marsh).

A *Cumberlandian type*, not in the interior basin (Mississippi and Ohio.)

Cumberland River, Tenn. (without exact locality) is the type-locality, but it has not been found nor been mentioned by Wilson & Clark (1914), but probably *Pleurobema crudum* (i. c. p. 57), if correctly identified, stands for the var. *tumescens* (large-river-form). The latter form is known from South Fork Cumberland, and also has been given by Hinkley and Marsh from Nashville. *F. barnesiana* is widely distributed in the Tennessee drainage, below and above Walden Gorge, in rivers of medium size.

Of this form of the medium rivers only comparatively few specimens have been found by myself in Duck River, yet one of them (a female from Columbia) is very interesting, because it demonstrates the identity of *U. validas* Lea (Duck River) with this. It is almost a counterpart of Lea's figure, only

* With regard to synonymy and nomenclature, compare: Ortmann, A. E. and Walker, B. Occas. Pap. Mus. Mich. 112, 1922.

slightly larger. Its diameter is 47% of the length, the same as that given by Simpson ('14 p. 750), while Lea's figure would give 49%. *U. validus* ('71) is thus an additionel synonym to *U. barnesianus* ('38) and corresponds most closely to *U. lyoni* Lea ('65).

2. *Fusconaia barnesiana bigbyensis* (Lea).

Duck R., Wilhoite, Shelbyville, Normandy; Buffalo R., Riverside; Garrison Cr., Wartrace.—Type locality: Big Bigby Creek (Lea).

At the localities where I found this form, it is the prevailing one, and it is not rare. The measurements confirm my view, that this is the compressed headwaters form of *F. barnesiana*. Also the larger size attained by *bigbyensis* is seen in specimens from Wartrace.

This flat form has not been reported from the Cumberland, but it is found abundantly in small streams of the lower and upper Tennessee region, going up into Virginia. My identification of the upper Tennessee specimens as *bigbyensis* is thus fully justified.

The large-river-form, *F. barnesiana tumesens*, has not been found in Duck River, but it is in the Cumberland (as *crudus*), and in the Tennessee from the Mussel Shoals to the Knoxville region.

3. *Megalonaias gigantea* (Barnes).

Duck River, Centreville, Columbia, above Columbia.—Scarce.—Reported from Columbia by Hinkley and Marsh.

In the Cumberland in the lower part up to Wayne County, Ky. At the Mussel Shoals of the Tennessee in northern Alabama; absent in the upper Tennessee. Widely distributed in the larger rivers of the interior basin (Mississippi, Ohio, etc.).

4. *Amblema costata* Rafinesque.

Duck R., Centreville, Ben, Columbia, above Columbia, Leftwich, Lillard's Mills, Wilhoite, Shelbyville.—Known from Columbia (Hinkley and Marsh, Marshall).

Widely distributed in the Cumberland and its tributaries (reported by Wilson and Clark from Cumberland proper as

Quadrula perplicata, passing in the upstream direction into *Qu. undulata* (equals) *A. costata*). In the Tennessee and its tributaries below and above Walden Gorge also abundant, going way up into the Clinch, Holston, French, Broad, etc.

Common in the Mississippi and Ohio drainages, but represented there, in the largest rivers, by forms called *A. perplicata* and *peruviana.*

5. *Quadrula pustulosa* (Lea).

Duck R., Centreville, Ben, Columbia, above Columbia, Leftwich.—Known from Columbia (Hinkley & Marsh).—Belongs to the lower and middle part of the river, not rare, at Columbia plentiful.

Abundant in the interior basin. In the Cumberland up to the falls; below Walden Gorge in Tennessee proper and lower parts of some tributaries; in the upper Tennessee up to the Knoxville region.

6. *Quadrula quadrula* (Rafinesque).

Duck River, Centreville, apparently not rare, since a good many dead shells were seen.—*New to the Duck River fauna.*

This species is common in the larger rivers of the interior basin, but has not been reported from the Cumberland by Wilson and Clark, and is not known from the Tennessee from the Mussel Shoals upward, but it is represented in the Cumberland and at the Mussel Shoals by *Qu. fragosa* (see next species). My specimens from Centreville are this, and not *fragosa,* of considerable size, with more or less transverse shape, the nodules only moderately developed, and the color of the epidermis typical.

7. *Quadrula fragosa* (Conrad).

Duck R., above Columbia, Lillard's Mills, Wilhoite.—Reported from Columbia (Hinkley and Marsh).—Only a few specimens taken by myself.

Wilson and Clark give this for Cumberland River, up to Wilson Co., Tenn., and from lower Harpeth river. At the Mussel Shoals of the Tennessee (specimens in Carnegie Museum, collected by H. H. Smith). Missing, as well as *Qu. quadrula,* in the upper Tennessee. The Carnegie Museum pos-

sesses a single specimen from the Cumberland at Nashville, confirming the record of Wilson and Clark. It has been reported from a number of places in the interior basin, but its geographical relation to *Qu. quadrula* is not clear. The fact of its occurrence in central Tennessee and northern Alabama might indicate that it is the upstream representative of Qu. *quadrula*, and this surely is the case in Duck River.

This species is hard to distinguish from *Qu. quadrula*, as admitted by Simpson ('14 p. 844). It differs by the more rounded-quadrate (not transverse) outline, with the nodules of the surface more strongly developed, and the brown, rayless epidermis. Yet there are specimens, which connect the two, but I have not found any intergrades in Duck River, where this species is found distinctly farther upstream than *Qu. quadrula*.

8. *Quadrula verrucosa* (Rafinesque).

Duck R., Centreville, Ben, Columbia, above Columbia, Leftwich, Lillard's Mills, Wilhoite, Shelbyville.—Reported from Columbia by Hinkley and Marsh.—Fairly abundant all along the river.

Widely distributed in the interior basin (and elsewhere). In Cumberland R., up to the falls, and also in some tributaries; common in the lower Tennessee and most of its tributaries. In the upper Tennessee known only from Hiwassee River, and missing in the Knoxville region and above.

9. *Quadrula intermedia* (Conrad).

Duck R., Columbia.—Given from the same place by Hinkley and Marsh.—I found only a single dead shell.

A Cumberland type, not found in the interior basin.

Rare in the upper Cumberland (reported as *Qu. tuberosa*). In the Tennessee at the Mussel Shoals and at Bridgeport, Ala., in the upper Tennessee chiefly toward the headwaters, and rare.

10. *Quadrula cylindrica* (Say).

Duck R., Ben, Columbia, Lillard's Mills, Wilhoite.—Reported from Columbia by Hinkley and Marsh.—Only a few specimen found by myself at each place. All over the interior re-

gion (and elsewhere). Also in Cumberland and Tennessee Rivers, up to Virginia, in larger and smaller streams.

11. *Cyclonaias tuberculata* (Rafinesque).

Duck R., Centreville, Ben, Columbia, above Columbia, Leftwich, Lillard's Mills, Wilhoite, Shelbyville.—Reported from Columbia by Hinkley and Marsh.—At most places quite abundant.

All over the interior basin, and abundant in the Cumberland, lower and upper Tennessee, in larger and smaller rivers, avoiding only the headwaters.

12. *Lexingtonia dolabelloides* (Lea).

Duck R., Ben, Columbia.—Reported from the latter place by Hinkley and Marsh (as *U. circumactus*), and abundant.

A *Cumberland type*, but peculiar to the Tennessee R., from the Mussel Shoals upward to the Knoxville region. Apparently missing in the Cumberland, although one of the synonyms (*U. subglobatus* Lea) has been given for (Florence, Ala., and) Nashville, Tenn. But it has never been found there subsequently, and is missing in the list of Wilson and Clark. It is a form of larger rivers, and represented, in the smaller ones, by the next form, and this holds good also for Duck River.

13. *Lexingtonia dolabelloides conradi* (Vanatta).

Duck, R., Ben, Columbia, Leftwich, Lillard's Mills, Wilhoite, Coffee Co.; Buffalo R., Riverside.—*New for Duck River system.*

Distribution similar to the preceding form. A *Cumberlandian type*, not reported from the Cumberland, but abundant in the lower and upper Tennessee, chiefly in the smaller streams and headwaters.

The gradual transition of *dolabelloides* into *conradi* is beautifully shown in Duck River. While at Ben and Columbia a certain proportion of the specimens falls under *dolabelloides* (diameter 50% of length or more), farther up only the compressed form (*conradi*) occurs (dia. less than 50%). At Wilhoite, in Coffee County, and in Buffalo River (Riverside) the diameter falls as low as 41 and 40%.

14. *Pleurobema cordatum* (Rafinesque).

Duck R., Columbia, rare.—*New to Duck River.*

Abundant in the Cumberland, and in the Tennessee up to the Knoxville region, generally associated with several of its varieties. Also abundant in the interior basin, chiefly in the Ohio, and preferring larger rivers.

The typical *cordatum* is in Duck River, but apparently rare; a fine, large specimen from the Sterki collection (in Carn. Mus.), without exact locality, is this, and I have found several at Columbia, which should be placed here, which are more or less typical, some of them, however, inclining by shallow radial furrow toward var. *catillus*, or by reddish nacre toward var. *pyramidatum*. The usual forms, in which the *cordatum*-group turns up in Duck River are the next two.

15. *Pleurobema cordatum catillus* (Conrad):

Duck R., Ben, Columbia, Leftwich, Wilhoite.—*New to Duck River.*

Distribution similar to that of the main species, and generally found associated with it. (However, west of the Mississippi it exists without *cordatum*).

This is decidedly more abundant in Duck River than the true *cordatum*, but it inosculates closely with the typical form, and also with the var. *pyramidatum*, having often reddish nacre.

Note: The *coccineum*-form of the *cordatum*-type, found occasionally in the Cumberland and Tennessee towards the headwaters, being merely a flattened *catillus*, has not been observed in Duck River.

16. *Pleurobema cordatum pyramidatum* (Lea).

Duck R., Columbia, Leftwich, Lillard's Mills, Wilhoite.—Given from Columbia by Hinkley and Marsh.

Distribution similar to that of the two preceding forms, and generally associated with them, but going a little farther upstream.

This is the most abundant form of the *cordatum*-group in Duck River, outnumbering the other two forms chiefly at the upper stations. The *pyramidatum*-type, however, is not well developed here, the shells being not extremely oblique, and

passing, in this character, into typical *cordatum*. The nacre is mostly red. The radial furrow is sometimes poorly developed, and specimens, which at the same time are little oblique, pass thus into *catillus*.

17. *Pleurobema oviforme* (Conrad).

Duck River, Columbia, Lillard's Mills, Wilhoite; Buffalo R., Riverside.—Reported from Columbia by Hinkley and Marsh (as: *clinchensis, lesleyi, and patulus*) * and from Duck River by Call (as *clinchensis* and *clavus*).

A *Cumberland type.*

From Cumberland River (South Fork and Rockcastle R.), *Pl. clava* has been reported by Wilson and Clark (if identification is correct), and the Carnegie Museum possesses two specimens of *clava*, labeled: Cumberland R., Tenn. The same form is present from the Mussel Shoals (Tuscumbia) from the Smith collection. I have seen it also in the Walker collection from Sequatchie R., Jasper, Marion County, Tenn. But it is sure that also *Pl. oviforme* is in the Cumberland drainage, for I collected myself a fine set of it in W. Fk. Stones R., Murfreesboro, Rutherford Co., Tenn. In the lower and upper Tennessee drainage *oviforme* is widely distributed, chiefly in the tributaries.

Pl. clava (Lamarck) is very closely allied to *oviforme*, and the latter may be easily mistaken for the former. This is the case in Call's report of *clava* from Duck River. Since he figures this form (the figure probably is enlarged), we are able to control the identification, and pronounce it a rather typical *oviforme*. The beaks are less anterior than in *clava*, and the contrast between the anterior, swollen part of the shell, and the compressed posterior (producing a kind of radial furrow in *clava*) is not seen: the shell tapers gradually from the front part towards the end. I have specimens from Wilhoite, which entirely correspond to Call's figure, and even approach it in size (L. 68 mm. Call's figure is 80 mm long, but his text gives 53 mm).

But it should not be forgotten that specimens of *clava* in

* It is very doubtful, whether these names all rest upon correct identification, in view of their close resemblance to *Lexingtonia*-forms.

the upper Ohio drainage sometimes approach the *ovidforme*-type, chiefly in young shells, and it might be possible that somewhere the two supposed species actually intergrade.

18. *Pleurobema oviforme argenteum* (Lea).

Duck R., Wilhoite; Buffalo R., Riverside.—*New for this drainage.*—A few only at the first place, abundant at the latter.

Also *restricted to the Cumberland region.*

This headwaters-form has not been reported from the Cumberland, but it may be present there. In the tributaries and the headwaters of the lower and upper Tennessee it is abundant.

Also in Duck River it is only in the headwaters, yet associated with typical *oviforme,* and passing into it. I have not seen here the specimens of great size, frequently observed in the Tennessee drainage.

19. *Pleurobema oviforme holstonense* (Lea).

Duck R., Ben, Columbia.—Reported from Columbia by Hinkley and Marsh (as *pattinoides*).—I found only a few specimens.

Also a *Cumberland type.*

Not reported from Cumberland system, but known from the Tennessee proper, and the lower parts of some of its tributaries, from the Mussel Shoals up to the Knoxville region.

Thus also in Duck River the law holds good, that this form represents the large-river-form of *oviforme;* at Columbia the two forms intergrade.

20. *Elliptio crassidens* (Lamarck).

Reported by Hinkley and Marsh (as *gibber*) from Columbia, and by Marshall (as *crassidens*) from Duck River. I did not find it, and no trace of it was seen among the thousands of dead shells lying on the gravel bars. Thus it must be rare, and possibly it belongs to the lower parts of the river. But I do not hesitate to admit it to the list, since it is impossible to mistake this species.

Abundant in the larger rivers of the interior basin, chiefly the Ohio drainage. In the Cumberland it goes up to the falls, and is also in the lower part of some of the tributaries. In

the Tennessee it is everywhere, up to the Knoxville region and above, avoiding only the headwaters.

21. *Elliptio dilatatus* (Rafinesque).

Duck R., Ben, Columbia, above Columbia, Leftwich, Lillard's Mills, Wilhoite.—Reported (as *gibbosus*) from Columbia by Hinkley and Marsh.—Abundant.

Everywhere in the interior drainage, as well as in the Cumberland and Tennessee, from the Mussel Shoals to the headwaters in Virginia, and in most of the tributaries.

The color of the nacre, in Duck River, is mostly darker or lighter purplish, very rarely white.

22. *Lastena lata* (Rafinesque):

Duck R., Columbia.—Given from same place by Hinkley & Marsh.—I found only a single male.

Wherever found, this is a rare shell, but it has a wide distribution in the interior basin, chiefly the Ohio drainage, going up, in the Cumberland, to Burnside, Pulaski County, Ky., It is in the lower Tennessee at the Mussel Shoals and in lower Elk River, and goes up, in the upper Tennessee and Clinch Rivers, to Virginia.

23. *Lasmigona* (*Alasminota*) *holstonia* (Lea).

Duck R., Manchester.—*New for Duck River.*—Half a dozen specimens found.

A *Cumberlandian species*, but apparently missing in the Cumberland, and existing only in the Tennessee system. *)

Wilson and Clark do not report it from the Cumberland, and I have not been able to find a single record from this drainage. In the lower, as well as the upper Tennessee system, however, it is rather abundant, but restricted to the smaller streams. In the lower Tennessee (below Walden Gorge), I know it from Jones Creek, Bridgeport, Jackson Co., Ala., and Battle Creek, Dover, Marion Co., Tenn. In the headwaters of the upper Tennessee it goes up to Virginia.

Also in Duck River, it has been found only at the uppermost station.

---

* In addition, it is also in the Alabama River system, but this does not interest us here.

24. *Lasmigona* (*Lasmigona*) *costata* (Rafinesque).

Duck R., Ben, Columbia, above Columbia, Leftwich, Lillard's Mills, Wilhoite, Shelbyville; Buffalo R., Riverside; Garrison Creek, Wartrace.—Reported from Columbia by Hinkley and Marsh.—Rather uniformly distributed, and abundant in the main river and tributaries.

A species of very wide distribution in the interior basin (and elsewhere), common also in the Cumberland, up to the falls, and the Tennessee, below and above the Gorge, going up to Virginia.

25. *Lasmigona* (*Pterosyna*) *complanata* (Barnes).

Duck R., Centreville, Ben, Columbia, above Columbia.—*New for Duck River.*—Not abundant, preferably in quiet pools above the riffles.

In quiet parts of larger rivers in the interior basin, also in the lower Cumberland, up to Harpeth River. Missing in the Tennessee from the Mussel Shoals upward.

26. *Anodonta grandis* Say.

Duck River, Shelbyville (three specimens in a muddy eddy below a riffle).—*New for Duck River.*

Of tremendous distribution in the interior basin (and elsewhere), but very rare in the Cumberland and Tennessee drainages. Reported from ponds near the Cumberland at Clarksville, Montgomery County, Tenn., and from Harpeth and Stones Rivers (found by myself in both of the latter). From the Tennessee, below the Gorge, I know it from Mountain Fork (of Flint R.), New Market, Madison Co., Ala. (Carn. Mus., coll. by H. E. Wheeler), and from the upper Tennessee it was known hitherto only from a pond near Knoxville. But recently (Aug. 16, '23) I found several specimens in Emory River (trib. to Clinch), at Wartburg, Morgan Co., Tenn.

This distribution appears as rather erratic and discontinuous. My Duck River specimens are not large, and represent the typical *grandis*, as found in streams of smaller size, but with the epidermis not so dark as usual. There are traces of

a purplish tint in the nacre. The beak-sculpture is normal. Max. size: L. 85, H. 54, D. 31 mm.

27. *Alasmidonta* (*Pressodonta*) *minor* (Lea):

Duck R., Shelbyville, Normandy; Buffalo R., Riverside.—*New for Duck River.*—Only a few specimens found.

A Cumberlandian type.

In the Cumberland above the falls (collected there by myself), and in some of the tributaries entering this river below the falls. In the Tennessee, below the Walden Gorge, it is in upper Elk River and the upper Sequatchie (Carnegie Museum); in the upper Tennessee it goes in the headwaters up to Virginia.

It is a typical small-creek form, strictly avoiding larger rivers. It is also in the uppermost Kentucky River, and I have seen specimens collected by E. Danglade in N. Fk. Kentucky River, Whitesburg, Letcher Co., Ky., which is not far from the headwaters of the Cumberland (See also: Danglade, Bur. Fish. Doc. 934. '22. p. 5). In the rest of the Ohio drainage, chiefly to the north of the Ohio River, it is represented by *A. calceolus* (Lea). The relations of the two species are obscure, but they are very closely allied.

28. *Alasmidonta* (*Decurambis*) *marginata* (Say).

Duck River, Columbia, above Columbia, Leftwich, Lillard's Mills, Shelbyville; Buffalo R., Riverside.—Reported from Duck River by Marshall.—Not abundant.

In the interior basin, and also in the Cumberland and its tributaries, up to the South Fork. Also in the Tennessee up to the headwaters. In the lower Tennessee it is absent or rare in the main river, but exists in most tributaries.

29. *Strophitus rugosus* (Swainson).

Duck R., Ben, Columbia, Lillard's Mills, Wilhoite, Shelbyville, Normandy; Buffalo R., Riverside; Garrison Cr., Wartrace.—Toward the upper parts rather abundant.—Reported from Columbia (as *schafferiana*) by Hinkley and Marsh.

Common everywhere in the interior basin (and elsewhere), chiefly in smaller rivers. Common also in the Cumberland and

Tennessee, up to the headwaters. In the Cumberland also above the falls.

Specimens from Duck River incline, in the main, toward the the form called *shaefferianus* (Lea), but not always. The epidermis generally is lighter and brownish, and also the nacre often shades into salmon tints, but the shape is very inconstant.

30. *Ptychobranchus fasciolare* (Rafinesque).

Duck R., Centreville, Ben, Columbia, above Columbia.—Not abundant.—Given for Columbia by Hinkley and Marsh (as *camelus*).

In the interior basin abundant, chiefly in the Ohio drainage. In Cumberland R., up to the falls, and in some tributaries. From the Mussel Shoals of the lower Tennessee, and several of its tributaries, into the upper Tennessee drainage, up to Virginia, but disappearing in the headwaters.

31. *Ptychobranchus subtentum* (Say).

Duck R., Columbia, Leftwich, Normandy; Buffalo R., Riverside. Only a few specimens found.—Reported from Columbia by Hinkley and Marsh.

A Cumberlandian type.

Found in the Cumberland from Rowena, Russell Co., Ky., up to the South Fork and the falls, and also in Rockcastle River. In the Tennessee, from the Mussel Shoals and the tributaries of the lower part up to the upper part, and well into the headwaters in Virginia. Most abundant in smaller streams above the range of *P. fasciolare*, and this seems to hold good also in Duck River.

32. *Obliquaria reflexa* Rafinesque.

Duck River, Centreville.—A single dead shell.—Reported from Columbia by Hinkley and Marsh.

Abundant in larger rivers in the interior basin. In the Cumberland in the main river up to the falls, and also in South Fork. In the Tennessee in the main river from the Mussel Shoals to the Knoxville region, entering here the lower parts of some tributaries.

33. *Cyprogenia irrorata* (Lea).

A single, very large specimen reported from Columbia by Hinkley and Marsh. I did not find a trace of it. But since the species is not easily to be mistaken, I admit it in the list.

Widely distributed in the Ohio drainage, the Cumberland, lower and upper Tennessee, preferring larger streams.

34. *Obovaria* (*Obovaria*) *retusa* (Lamarck).

Given from Columbia by Hinkley and Marsh. Since this species is easily recognized, it should be admitted, although I did not find it.

In the Ohio drainage, the Cumberland, and the Tennessee, up to the Knoxville region, but apparently rare in the Tennessee.

35. *Obovaria* (*Obovaria*) *subrotunda* Rafinesque.

Duck R., Columbia, Wilhoite.—Several specimens at the first place, only one at the other, standing close to the next form.—Hinkley and Marsh give it (as *circulus*) from Columbia.

In the interior basin chiefly in the Ohio drainage, in the larger rivers. In the Cumberland, this form and the next have not been separated, but apparently both are found, as usual, *subrotunda* farther down, *lens* farther up. In the Tennessee below the Gorge, this form has not been reported from the main river, but it is present but rare, in the Knoxville region.

36. *Obovaria* (*Obovaria*) *subrotunda lens* (Lea.).

Duck R., Ben, Columbia, above Columbia, Leftwich, Lillard's Mills, Wilhoite, Shelbyville; Buffalo R., Riverside.—More abundant than the main form, and taking its place in the upper reaches of the river.—*New for the system.*

Distribution similar to that of the main species, but preferring the smaller streams. It is in the Cumberland drainage (surely in Harpeth River, for *U. depygis* Conrad is a true *lens*), and quite frequent in tributaries of the lower Tennessee. In the upper Tennessee it is, like the main species, rare.

Also in Duck River it is evident, that *subrotunda* is the swollen large-river-form, *lens* the more compressed form farther up. A single specimen of *O. subrotunda*, found at Wilhoite,

makes an exception, but with a diameter of only 62% it stands close to *lens*. At Ben only two specimens were found, one of them, with the diameter of 59%, coming close to typical *subrotunda*.

37. *Actinonaias carinata* (Barnes).

Duck R., Ben, Columbia.—Not very abundant.—*New for Duck River.*

Very abundant in the interior basin, and chiefly in the Ohio drainage. The typical *A. carinata* is not found in the Cumberland and Tennessee, but is represented there by the var. *gibba* Simpson. This fact is extremely remarkable: the specimens from Duck River undoubtedly belong to the typical *carinata* (the "northern mucket"), and do not have the humped shape of the "southern mucket" (*gibba*). It is true, var. *gibba* is not very well marked, as specimens from the Cumberland and Tennessee often approach the Ohio-form; and, on the other hand, specimens from Green River, Kentucky, are again more like *gibba*. Yet, as a rule, the two forms are separable.

38. *Actinonaias pectorosa* (Conrad).

Duck R., Ben, Columbia, above Columbia, Leftwich, Lillard's Mills; Buffalo R., Riverside.—Abundant at Columbia and Leftwich.—Recorded by Hinkley and Marsh from Columbia (as *perdix*).

A *Cumberlandian form*, missing in the interior basin.

Reported, in the Cumberland, from Cloyd's Landing, Cumberland Co., Ky., to the South Fork and the falls, also from some of the tributaries. In the Tennessee, below the Walden Gorge, at the Mussel Shoals, and in several of the tributaries; in the upper Tennessee chiefly towards the headwaters, as far up as Virginia, sometimes quite abundant.

Also in Duck River, this species has its metropolis farther up in the river, than *A. carinata*.

39. *Plagiola lineolata* (Rafinesque).

Reported from Columbia by Hinkley and Marsh (as *securis*). Not seen by myself, but easily recognized. Thus it should be credited to Duck River.

Common in Ohio and Cumberland drainages. In the Tennessee up to the Knoxville region, but rare there.

40. *Truncilla truncata* (Rafinesque).

Duck R., Columbia.—Several specimens.—Reported from the same place by Hinkley and Marsh (as *elegans*).

Of very wide distribution in interior basin and elsewhere. In the Cumberland up to the South Fork and the falls, and also in some tributaries. In the lower Tennessee at the Mussel Shoals, in Bear Creek, and Paint Rock River; rare in the upper Tennessee in the Knoxville region.

41. *Truncilla donaciformis* (Lea).

Duck R., Centreville.—Only one dead shell.—Reported from Columbia by Hinkley and Marsh.

Distribution very much like that of the preceding species, but with some differences. It exists in the Cumberland and in the lower Tennessee (Mussel Shoals and Paint Rock River), but is missing in the upper Tennessee, where *T. truncata* is found.

42. *Leptodea leptodon* (Rafinesque).

Reported (as *tenuissimus*) by Hinkley and Marsh from Columbia. Easily recognized, and thus admitted. I may have overlooked it, since dead shells are not apt to be preserved very long.

A rare species, but widely distributed in the interior basin, the Cumberland, lower and upper Tennessee.

43. *Leptodea fragilis* (Rafinesque).

Duck R., Centreville, Columbia, Lillard's Mills.—Not abundant.—Reported from Columbia by Hinkley and Marsh (as *gracilis*).

Widely distributed in the interior basin. In the Cumberland all along the river up to the South Fork, but not in the tributaries. In the Tennessee below the Gorge, and some of its tributaries; also in the upper Tennessee, with the exception of the headwaters.

44. *Proptera alata* (Say).

Duck R., Centreville, Ben, Columbia.—*New for Duck River.*

Living specimens were taken at the first station, and they were not rare there (chiefly in the quiet pool above the riffles). At the other two localities only a few dead shells were seen.

Distribution very much like that of the preceding species, and generally abundant, also in the Cumberland and Tennessee, with exception of the headwaters. Prefers larger rivers, but sometimes also in smaller ones.

45. *Carunculina moesta* (Lea).

Duck R., Wilhoite, Shelbyville.—Several specimens.—*New for Duck River.*

A *Cumberlandian type*, missing in the interior basin (but represented there by *C. glans*). Reported from tributaries of the Cumberland; known from tributaries of the lower Tennessee, and locally from smaller streams in the upper Tennessee region.

My specimens from Duck River are quite typical in shape and color of epidermis and nacre.

46. *Carnuculina cylindrella* (Lea).

Duck R., Coffee Co.; Buffalo R., Riverside.—A number of specimens at the first locality, only one of the second.—Reported from Columbia by Hinkley & Marsh. Duck River is Lea's type locality.

A *Cumberlandian type*, but not known from the Cumberland drainage, and not known from the upper Tennessee. The Carnegie Museum possesses specimen from the lower Tennessee drainage: upper Elk River, and Flint River in Madison Co., Ala.

This species stands very close to *C. moesta*, but differs in paler (greenish-yellowish) epidermis, and paler nacre. The latter may be purplish, or of a peculiar yellowish-white tint. Such specimens are occasionally found in the upper Tennessee region, but always associated with *moesta*. In *C. cylindrella*, the shell is slightly more elongated, both in the male and female, and the postbasal dilatation of the female is less developed than in *moesta*. It is quite possible, that *cylindrella* is only a variety of *moesta*, but in my material from Duck River the two are sharply distinct.

47. *Conradilla caelata* (Conrad).

Duck R., Hickman Co. (Hartman coll.), Columbia, Leftwich.—Only one specimen at each of the latter two localities found by myself.—Found at Columbia by Hinkley and Marsh.

A *Cumberlandian type*, missing in the interior basin, and absent also from the Cumberland drainage. Restricted to the lower and upper Tennessee, from the Mussel Shoals, Elk and Flint Rivers (Morgan Co., Ala.), to the Clinch, Powell, and Holston Rivers, up into Virginia.

48. *Medionidus conradicus* (Lea).

Duck R., Columbia, Leftwich, Lillard's Mills, Wilhoite, Shelbyville, Normandy; Garrison Creek, Wartrace.—Locally abundant, chiefly at the upper stations.—Found at Columbia by Hinkley and Marsh.

A *Cumberlandian type*, not present in the interior basin, but common in the upper part and tributaries of Cumberland River (not above the falls), and in the lower and upper Tennessee drainage, chiefly in the tributaries, up to Virginia.

49. *Micromya fabalis* (Lea).

Duck R., Wilhoite.—Several specimens found by myself.—Reported from Columbia by Hinkley and Marsh, and by Marshall.

In the interior drainage chiefly in tributaries of the Ohio, not rare. Not reported from the Cumberland by Wilson and Clark, and apparently absent there, as well as missing in the Tennessee below Walden Gorge. Present, however, in the upper Tennessee, chiefly in the headwaters from the Knoxville region into Virginia.

It is quite possible that this species has been overlooked in the Cumberland and lower Tennessee.

50. *Micromya nebulosa* (Conrad).

Buffalo R., Riverside.—Abundant at this place.—*New for Duck River system.*

A Cumberlandian type, but represented in the interior basin by *M. iris.*

Of the many synonyms of this species, several have been originally reported from the Cumberland system: *U. cumber-*

landianus Lea, *notatus* Lea, admitted by Simpson as synonyms; and the following added by Ortmann: *U. obscurs* Lea; *simus* Lea. Call gives also *U. iris* from Rockcastle River. However, none of these has been mentioned from the Cumberland by Wilson & Clark. Yet *M. nebulosa* does exist in the Cumberland drainage, for I have found it myself in the upper Caney Fork at Riverhill, White Co., Tenn. (S. of Sparta), and in its tributary, Barren Fork, at McMinnville, Warren Co., Tenn., and further, the Carnegie Museum possesses specimens collected by C. Goodrich in September, 1923 in Pitman Creek, at Burnside, Pulaski Co., Ky.

In the Tennessee drainage below and above the Walden Gorge, this species is present. It is rare in the larger rivers, but practically everywhere in the smaller streams, and goes, in the headwaters, into Virginia.

Outside of the Cumberland region, it has not been positively found, although some of its synonyms have been occasionally reported; but probably all these records refer to *M. iris*, which, possibly, is only a variety of it.

It is remarkable that in the Duck River drainage, I found this species only in Buffalo River, but that it was extremely abundant here, and associated with, and hard to distinguish from, the next species. Probably it will be found in some other small tributaries of Duck River.

51. *Micromya taeniata* (Conrad).

Duck R., Shelbyville, Normandy; Buffalo R., Riverside.—Few at the first two localities, abundant at the third.—*New for Duck River.*

A Cumberlandian type, reported under various names (*taeniatus, pictus, punctatus*) from the upper Cumberland by Wilson and Clark. I found it myself in West Fork Stones River, and the Carnegie Museum has it from Pitman Creek, Burnside, Ky. (Goodrich). Also known from the lower Tennessee at the Mussel Shoals and from several tributaries in this region, but missing in the whole upper Tennessee system above the Gorge.

This species is very close to *nebulosa:* it is larger, and the color pattern is slightly different, consisting of rather broad,

more or less interrupted rays, often dissolving into isolated spots. Just the latter character is very variable, and has caused the creation of several nominal species. But I am unable, for instance, to distinguish: *taeniate, picta,* and *punctata.* The forms of this group require additional study, and also their relation to *M. nebulosa* should be investigated more closely.

Outside of the Cumberland region, in the interior basin, no shells of the *taeniata* type are known.

52. *Micromya vanuxemensis* (Lea).

Duck R., Shelbyville, Normandy; Buffalo R., Riverside; Garrison Creek, Wartrace.—Abundant at Shelbyville and Riverside.—*New for Duck River.* *)

A Cumberlandian type, not known in the interior basin (but represented in the upper Alabama drainage). From the Cumberland system, it has been reported by Wilson and Clark (W. Fk. Red R., Ringgold, Montgomery Co., Tenn.), and probably *lienosa* from the main river at Clarksville, from below the falls, and E. Fk. Stones R., also belongs here. In the lower and upper Tennessee this species is abundant, generally preferring the smaller streams.

However, specimens from larger rivers in the upper Tennessee drainage, as well as from the whole lower Tennessee drainage, and from Duck River, do not represent the typical phase of the species, and do not have, in the female, that characteristic constriction of the shell behind the postbasal expansion, or it is only weakly indicated (equals *pybasi*-type). Such forms approach *M. lienosa* (Conrad) of the Alabama system, and we apparently have here the actual transition between the two forms, which explains the fact that repeatedly the latter has been reported from the upper and lower Tennessee and from the Cumberland.

My specimens from the Duck system have mostly dark-purple nacre, often with whitish margin. But one female from Wartrace is entirely white inside. A male from Shelbyville

---

* Unless *U. nashvillensis,* reported by Hinkley & Marsh from Columbia, should be this. The large specimen of *M. vanuxemensis,* mentioned below, might suggest this.

has gigantic proportions: L. 75, H. 43, D. 27 mm. The normal maximum length is between 50 and 60 mm.

53. *Ligumia recta latissima* (Rafinesque).

Reported from Columbia by Hinkley and Marsh. It should be included in the list, since this species is unmistakable. I did not see a trace of it.

Common everywhere in the interior basin, the Cumberland, lower and upper Tennessee, but apparently rare in Duck River.

54. *Lampsilis anodontoides* (Lea).

Duck R., Centreville.—Rather abundant, but only dead shells found.—*New for Duck River.*

A common form in the larger rivers of the interior basin, going up, in the Cumberland, to Willson Co., Tenn. Also in lower Harpeth River. In the Tennessee, it is known only from the Mussel Shoals (Hinkley, Nautilus, 20, '06), but not higher up.

55. *Lampsilis ovata* (Say).

Duck R., Ben, Columbia, Leftwich, Wilhoite.—Not rare.—Mentioned from Columbia by Hinkley and Marsh.

A form of wide distribution in the Ohio drainage, chiefly in the larger rivers, but apparently missing from the lower Ohio westward and northward. In the Cumberland it is all along the main river up to the falls (transplanted above the falls). Also everywhere in the Tennessee proper, from the Mussel Shoals (and lower Paint Rock River) up to the Knoxville region, and going here upward a certain distance in the larger tributaries.

56. *Lampsilis ovata ventricosa* (Barnes).

Duck R., Columbia, above Columbia, Lillard's Mills, Wilhoite, Shelbyville; Buffalo R., Riverside; Garrison Creek, Wartrace.—Not rare.—*New for Duck River*

Distribution similar to that of the preceding form, often associated and intergrading with it, and gradually taking the place of it in the headwaters. In the Cumberland system chiefly in the tributaries. Everywhere in the Tennessee drain-

age, but again mostly in the tributaries and the headwaters, up to Virginia.

Also in Duck River, *ventricosa* gradually displaces *ovata* in the upstream direction. Intergrades between the two are frequent.

57. *Lampsilis fasciola* (Rafinesque).

Duck R., Columbia, Leftwich, Lillard's Mills, Wilholte; Buffalo R., Riverside; Garrison Cr., Wartrace.—Rather abundant. —Reported from Columbia by Hinkley and Marsh (as *perradiatus*) and Marshall (as *multiradiatus*).

Very widely distributed in the Ohio basin, yet apparently rare or missing in the Mississippi, preferring streams of medium or small size. In the Cumberland abundant, chiefly in the upper parts, below the falls, and in tributaries. Everywhere in the lower and upper Tennessee drainage, and most abundant in the tributaries up to the headwaters in North Carolina and Virginia.

58. *Dysnomia* (*Truncillopsis*) *triquetra* (Rafinesque).

Duck R., Columbia, above Columbia, Leftwich, Wilhoite, Shelbyville.—Rare.—Reported from Columbia by Hinkley and Marsh (as *triangularis*).

Frequent in the interior basin, chiefly in the Ohio drainage. Reported by Wilson and Clark from the Cumberland, up to Russell Co., Ky., and from Obey River. Of general distribution in the lower and upper Tennessee, in larger and smaller rivers.

59. *Dysnomia* (*Truncillopsis*) *brevidens* (Lea).

Duck R., Columbia, Wilhoite.—Only two living and one dead specimen found by myself.—Mentioned from Columbia by Hinkley and Marsh.

A Cumberlandian type, missing in the interior basin. Reported from the Cumberland at Nashville by Conrad, and by Wilson and Clark from Beaver Creek and the South Fork. Known from the lower Tennessee from the Mussel Shoals and Elk River. More abundant in the upper Tennessee in the Knoxville region and above.

60. *Dysnomia* (*Truncillopsis*) *lenior* (Lea).

Given from Columbia by Hinkley and Marsh. It could only

be confounded with *brevidens*, but since also the latter has been mentioned by the same authors, the identification must be accepted. I did not see it, but it is a rare species, easily overlooked.

The type locality is in Stones River (Cumberland drainage). In the Tennessee system, below the Gorge, it is frequent in Paint Rock River; in the upper Tennessee it is in the headwaters of the Clinch and Holston. Thus it is *a Cumberlandian type*, absent in the interior basin.

61. *Dysnomia* (*Pilea*) *turgidula* (Lea).

Duck R., Shelbyville.—Abundant.—Given from Columbia by Hinkley and Marsh (as *deviatus* and *turgidulus*).

A Cumberlandian type. * Reported by Lea from Cumberland River, but not by Wilson and Clark. Found in the lower Tennessee at the Mussel Shoals in Alabama (Lea), in Bear Creek, (Carn. Mus.), and Shoals Creek (Hinkley). In the upper Tennessee system it is in Holston and Emory Rivers.

This species is a close relation to *D. biemarginata* (Lea) (see: Ortmann, Proc. Amer. Philos. Soc. 57, '18, p. 590), and may be the headwaters-form of it. *D. biemarginata* is known from the lower Tennessee and its larger tributaries (Elk and Paint Rock Rivers). Aside from Lea's record for *turgidula from* Cumberland River, *D. biemarginata* is in the Cumberland and the South Fork at Burnside, Ky. (Walker collection).

The material collected by myself at Shelbyville is very fine, containing a good number (about two dozen) of males and females (among the latter gravid ones) of different ages.

62. *Dysnomia* (*Pilea*) *florentina walkeri* (Wilson and Clark).

Duck R., Lillard's Mills, Wilhoite.—Rare.—This is probably the form reported as *florentinus* from Columbia by Hinkley and Marsh.

A Cumberlandian type, missing in the interior basin. Found

* It is present also in the Ozark region, in Missouri as *Truncilla curtisi* Frierson and Utterback (Amer. Midl. Natural., 4, 1916, p. 90). This peculiar distribution is found in some other Cumberlandian forms (*Carunculina moesta*, for instance), and is highly interesting and significant, but may be dismissed for the present.

in the Cumberland system at the type locality, E. Fk. Stones R., Walterhill, Rutherford Co., Tenn. (Wilson and Clark), and in Harpeth R., Belleview, Davidson Co., Tenn. (dead shell collected by myself). It exists in tributaries of the Tennessee, below the Walden Gorge; Flint R., and Hurricane Cr., Gurley and Maysville, Madison Co., Ala. (Carn. Mus.), and Limestone Cr., Mooresville, Limestone Co., Ala. (Walker collection), and in the upper Tennessee drainage in Holston R., up to Virginia (see: *Truncilla florentina* and *walkeri*, Ortmann, Proc. Amer. Philos. Soc. 57, 1918, pp. 591, 592).

D. florentina and *walkeri* are closely allied, and intergrade with each other. Specimens from the lower Holston (above Knoxville), which I mentioned (l. c) as *Tr. florentina*, are intergrades, but should be better placed with *walkeri*, which should be regarded as a variety of *florentina*.

Since this has not been fully realized hitherto, I think it would be in order to substantiate this by a fuller account of the material at hand.

At the Mussel Shoals, the type locality for *florentina*, both the height and diameter of the *male* shell is great, the H. being from 75-79% (average 77%) of the length. At all other localities (Stones R., Duck R., Flint R., lower and upper Holston) the H. is less, between 66 and 75%, and only in the lower Holston it reaches the maximum of 75%. Thus, for the *male*, *the H. of the shell can be used to distinguish florentina and walkeri*, the former having the H. of 75% or over, the latter less than 75%, keeping in mind, that in the lower Holston transitional specimens are present.

For the *female*, H. is not important, for, at the Mussel Shoals, it averages 73.5%, in Duck R., 75%, in Flint R, 76%, in the lower Holston 76%, upper Holston 77%, Harpeth R., 73%, Stones R., (type loc. for *walkeri*) 73%, the minima and maxima of the several localities broadly overlapping. For this condition apparently the great variability in the development of the postbasal expansion is responsible.

The D. of the *male* at the Mussel Shoals also is great. It varies from 50 to 62%, with an average of 57%. At other places, it is distinctly less, as is shown by the following aver-

ages: Duck R., 45%, Flint R., 45%, lower Holston, 50%, upper Holston, 40%, Stones R., 45.5%. Again we have, in the lower Holston, a close connection of the two forms, the D. varying here from 47 to 52%, so that the males from the lower Holston stand very near to the typical *florentina*, although the latter (from the Mussel Shoals) are in the average more swollen.

It is the Diameter of the shell, by which the females of the two forms may be separated. At the Mussel Shoals, it is 50 to 53% (average 51.5%, but comparatively few specimens at hand.) At the other localities it is never over 50%, and it is again in the lower Holston, where this figure reaches the maximum, the average being 47%. For the rest, it is considerably lower: 42% in Duck R., 43% in Flint R., 41% in the upper Holston, 41% in Harpeth R., and 40% in Stones R.

Thus we get the following diagnostic characters:

Male: H. 75% or over; D. 50% or over. Female: D. 50% or over ---------- *florentina*

Male: H. under 75% D. mostly under 50%. Female: D. less than 50% ---------- *walkeri*

This is an additional case to those given by me (Proc. Amer. Philos. Soc. 59, '20, p. 269 ff.), where the *Diameter (or obesity), of the shell changes with the size of the river:* the larger rivers have the swollen *florentina* (Mussel Shoals only, thus far); in the smaller ones this passes into the more compressed *walkeri*. In the lower Holston we have the actual intergrades.

There is an additional character to be considered. This is absolute size. According to the material at hand, *florentina* from the Mussel Shoals, and *walkeri* from the Duck, Flint, and lower Holston, are rather small (maximum L. in males 39 to 42 mm., in females 33 to 38 mm), while in upper Holston, Harpeth, and Stones, the maxima are: males 51 to 52 mm., females, 48 to 58 mm. This is a great contrast, but cannot be used for the distinction of the two forms, since it does not apply to the *walkeri*-type of Duck, Flint, and lower Holston. But, of course, it again suggests the close connection of these forms.

The males of *D. florentina walkeri*, closely resemble those of the next species (*capsaeformis*), but they differ chiefly in

color. The epidermis is yellowish-brown, with greenish rays, the latter not very sharply defined, but never confluent into a broad, dark-green area upon the flattened part of the disk. *D. capsaeformis* is greenish, with darker rays, and a dark green area (corresponding to the dark green expansion of the female), which is practically always visible, and often very striking.

63. *Dysnomia* (*Pilea*) *capsaeformis* (Lea).

Duck R., Columbia, Leftwich, Lillard's Mills, Wilhoite.—Rather abundant.—*New for Duck River.*

A Cumberland type, not found outside of this region, but quite abundant in it. Known in the Cumberland from Nashville up to the South Fork. Everywhere in the lower Tennessee in the main river and most of its tributaries, and in the upper Tennessee in larger and smaller streams up to Virginia.

In all females collected, the "pad" of the mantle margin was grayish to blackish, and never of that peculiar blueish or greenish-white so often seen in upper Tennessee specimens.

FAUNISTIC AFFINITIES OF THE DUCK RIVER NAIADES.

My chief object in publishing the above list of Duck River Naiades is to ascertain the relations of this fauna to others, and its probable origin. But not all species can be used for this purpose. There is a large number of them, which are very widely distributed, without pointing to any particular river system, and this holds good for all those, which are rather uniformly found in the "interior basin" (to which Duck River belongs at the present time), that is to say, chiefly in the Ohio, Cumberland, and Tennessee, below and above the Walden Gorge. The following forms belong to this class:

1. *Amblema costata*
2. *Quadrula pustulosa*
3. *Qu. verrucosa*
4. *Qu. cylindrica*
5. *Cyclonaias tuberculata*
6. *Pleurobema cordatum*
7. *Pl. cord. catilus*
9 *Pl. cord, pyramidatum*
9. *Elliptio crassidens*
10. *Ell. dilatatus*
11. *Lastena lata*
12. *Lasmigona costata*
13. *Anodonta grandis*
14. *Alasmidonta marginata*
15. *Strophitus rugosus*
16. *Ptychobranchus fasciolare*
17. *Obilquaria reflexa*
18. *Cyprogenia irrorata*
19. *Obovaria retusa*
20. *Ob. subrotunda*

21. *Ob. subrotunda lens*
22. *Plagiola lineolata*
23. *Truncilla truncata*
24. *Leptodea leptodon*
25. *L. fragilis*
26. *Proptera alata*
27. *Ligumia recta latissima*
28. *Lampsilis ovata*
29. *L. ov. ventricosa*
30. *L. fasciola*
31. *Dysnomia triquetra*

Some of these are decidedly rare in the upper Tennessee, namely: *Quadrula verrucosa, Anodonta grandis, Obliquaria reflexa, Obovaria retusa, Obovaria subrotunda, Obovaria subrotunda lens, Plagiola lineolata;* and these lead us to another group of species, which have a similar wide distribution as those named above, but are *missing in the upper Tennessee:*

32. *Megalonaias gigantea*
33. *Quadrula fragosa*
34. *Truncilla donaciformis*
35. *Lampsilis anodontoides*

These 35 forms make 56% of the total of the Duck River fauna, that is to say, over half of it consists of elements which have a very wide distribution over most of the present interior drainage.

These species do not tell us more than the obvious fact, that the Duck River fauna largely belongs to the Mississippi-Ohio basin, as it ought to, since, at the present time, Duck River (as well as Cumberland and Tennessee) form part of this hydrographic basin. The four last named forms, however, suggest that the immigration was in this region in an upstream direction, for these species have not been able to reach the most remote part of this drainage, the upper Tennessee. This may be the case also in at least some of the others, and it should be pointed out, that, with the exception of *Anodonta grandis,* which is a small creek- and pond-form, all these species are either large-river-forms, or else inhabit indiscriminately larger and smaller streams. This would place their centre of radiation well downstream, i. e. near the centre of the interior basin, in the region of the lower Ohio. Of course, it is impossible to exactly locate the place of origin, without detailed study of the range of each species, and, on the other hand, it is quite possible, that some of them actually have originated in the Cumberland region, whence they migrated down the rivers toward the Ohio.

To the above list we are to add several other shells, which

seem to have had a similar upstream direction of migration, but which did not reach all of the Cumberland-Tennessee region.

First, there is a species widely distributed in the interior basin, and found in the Cumberland, but altogether missing in the Tennessee:

36. *Lasmigona complanata*

Further, there are two species, also of wide distribution in the interior basin, and existing also in Duck River, but absent from both the Cumberland and Tennessee drainages:

37. *Quadrula quadrula* 38. *Actinonaias carinata*

And finally a species should be mentioned of rather irregular distribution:

39. *Micromya fabalis*

This is in Duck River and the upper Tennessee, but not in the Cumberland and the lower Tennessee. In the Ohio-drainage, it is abundant, and thus it surely falls in this general group of widely distributed species.

Thus the percentage of forms (39) which probably or possibly are to be regarded as *elements belonging to the interior basin* (Ohio-drainage chiefly) rises to about 62%.

All other species of Duck River (about 38%) are not known from the interior basin, i. e. not from outside of the Cumberland-Tennessee drainages. They are the *Cumberlandian* types, which designation may be properly used for them, because they largely belong to the Cumberland Plateau and the Great Allegheny Valley (upper Tennessee). A *Cumberland Region*, in this sense, and applied to *freshwater forms*, naturally recalls the "Cumberland subregion" introduced by W. G. Binney (See: Bull. U. S. Nat. Mus. No. 28, '85 p. 33) for the *Land-Gastropods*, forming a subdivision of the "Interior Region" of the "Eastern Province." The boundaries of this subregion have been variously defined, but they always included the Great Valley of Eastern Tennessee, and more or less of the adjoining parts, chiefly of the Cumberland Plateau. The Cumberland Region in our sense, refers to freshwater life, and includes the *drainages of the Cumberland and Tennessee rivers*

only, from the headwaters down, but leaving out the lowermost sections of the two rivers. It ends, in the Cumberland, about in the vicinity of Clarksville, Montgomery Co., Tenn., for below this point hardly any Cumberlandian shells are known. In the Tennessee, the lower limit of this fauna has not been determined. The Mussel Shoals in Alabama surely possess this fauna, but the whole Tennessee below this point is entirely unknown. Duck River empties into this part of the Tennessee, and, according to my collections, also the lower part of Duck River does not seem to belong any more to the Cumberlandian Region (see below).

Nobody ever has made an attempt to study the Cumberlandian Naiad-fauna, and to single out the forms belonging to it, although attention frequently has been called to the fact, that in this general region a great number of peculiar mussels are found. Thus it will be of interest to know *which species should be regarded as Cumberlandian in the sense here defined.*

It should be noticed that these Cumberlandian shells are not all uniformly distributed over the Cumberland and Tennessee drainages, although there are some which are so. But others are more local. Further, a study of these forms (and of others) brings out the fact, that the Tennessee drainage itself is divided into two sections, that *below Walden Gorge* (below Chattanooga), with its tributaries down to the Mussel Shoals, and that *above this point*, including all the headwaters.†)

Duck River species of general distribution in Cumberland, lower and upper Tennessee: *

---

* Also in the Cumberland such a division is evident, namely the part below the falls, and that above. But the latter is rather small and poor in species. Nevertheless, zoögeographically, it surely is interesting, and should receive due consideration in a special study of the Cumberland River fauna.

† In some of the varieties the distribution is not fully known, chiefly in the Cumberland, because their taxonomy has not been studied from the modern viewpoint introduced by myself in my paper on the upper Tennessee shells (Proc. Amer. Philos. Soc. 57., '18). Thus it was necessary sometimes, to unite these forms into groups.

1, 2. *Fusconia barnesian* (two varieties, but only one in Cumberl.; a third not in Duck).
3. *Quadrula intermedia*
4, 5, 6. *Pleurobema oviforme* (three varieties, only one positively in Cumberland).
7. *Alasmidonta minor*
8. *Ptychobranchus subtentum*
9. *Actionaias pectorosa*
10. *Carunculina moesta*
11. *Medionidus conradicus*
12. *Micromya nebulosa*
13. *M. vanuxemensis*
14. *Dysnomia brevidens*
15. *D. lenior*
16. *D. turgidula*
17. *D. florentina walkeri*
18. *D. capsaeformis*

Duck River species found in the lower and upper Tennessee, but not in the Cumberland:

19. *Lexingtonia dolabelloides*
20. *L. dolab. conradi*
21. *Lasmigona holstonia*
22. *Conradilia caelata*

Duck River species found in Cumberland and lower Tennessee, but not in upper Tennessee:

23. *Micromya taeniata*

Duck River species found only in lower Tennessee, but not in Cumberland, and not in upper Tennessee:

24. *Carunculina cylindrella*

Thus 24 species of the Duck River fauna are Cumberlandian types, that is to say, 38% of the fauna.

It should be pointed out, that there are no species in Duck River, which are present only in the Cumberland, but not in the Tennessee, as there seem to be no Cumberlandian species, restricted to the Cumberland alone, i. e. *Cumberland River has no peculiar species of its own!*

These 24 forms enumerated above are not all the Cumberland-types known. There are others, found either in Cumberland and Tennessee, or in Tennessee alone, which have not been found in Duck River. I think it is well to give here a list of them, with short indications of their distribution, so that *we thus get a complete account of what should be called the Cumberlandian Naiad fauna.*

I leave out the group of *Fusconaia pilaris*, because, probably, *pilaris* should not be separated from *subrotunda* of the interior basin.

25. *Fusconala cuncolus* (Lea)—26. *F. cun. appressa* (Lea).—In lower and upper Tennessee, but not in Cumberland, the former in small

streams, the latter in larger ones.

27. *Fusconaia edgariana* (Lea)—28. *F. edg. analoga* (Ortmann).—Like the preceding two forms, the former in the larger, the latter in the smaller streams.

29. *Fusconala barnesiana tumescens* (Lea).—Reported from the Cumberland (as *Pleurobema crudum*). In larger rivers in lower and upper Tennessee.

30. *Quadrula cylindrica strigillata* (Wright).—Headwaters of Powell, Clinch, and Holston only.*)

31. *Pleuthobasus cyphyus compertus* (Frierson).—Local form in the Knoxville region.

32. *Alasmidonta* (*Decurambis*) *raveneliana* (Lea).—Local form in headwaters of French Broad and Pigeon Rivers in North Carolina.

33. *Pegias fabula* (Lea).—In the Cumberland drainage in Rockcastle and Stones River; small streams of lower, and headwaters of upper Tennessee.

34. *Dromus dromas* (Lea).—35. *Dr. dr. caperatus* (Lea).—Cumberland, lower and upper Tennessee, the former in the larger rivers, the latter in the smaller ones; the small-river form has not yet been found in lower Tennessee.

36. *Micromya trabalis* (Conrad).—Metropolis in Cumberland and tributaries. Rare in lower Tennessee (Mussel Shoals and Paint Rock River). In upper Tennessee only in Chickamauga Creek (near Chattanooga) and in Hiwassee River.

37. *Micromya perpurpurea* (Lea).—Only in Clinch, Powell, and Emory Rivers, representing *trabalis*.

38. *Lampsilis virescens* (Lea).—In lower Tennessee, Emory River, and Coal Creek (Clinch drainage) (See: Ortmann, '18 p. 582). Recently an additional locality has been discovered: Emory R., Wartburg, Morgan Co., Tenn.

39. *Dysnomia* (*Truncillopsis*) *araeformis* (Lea.)—Upper Cumberland and lower Tennessee (Mussel Shoals) (rare). Abundant in the Knoxville region of the upper Tennessee.

40. *Dysnomia* (*Scalenilla*) *haysiana* (Lea).—Not rare in Cumberland, lower and upper Tennessee.

41. *Dysnomia* (*Dysnomia*) *stewardsoni* (Lea).—Knoxville region of upper Tennessee.

42. *Dysnomia* (*Dysnomia*) *lewisi* (Walker).—Cumberland River, Burnside, Ky., and Knoxville region of the upper Tennessee.

43. *Dysnomia* (*Pilea*) *torulosa gubernaculum* (Reeve).—Upper Tennessee from the Knoxville region upward.

44. *Dysnomia* (*Pilea*) *biemarginata* (Lea).—Probably large-river-form of *D. turgidula*. Known from Cumberland (Burnside) and the Mussel Shoals in the lower Tennessee. Not in upper Tennessee.

---

* I do not believe that it is found elsewhere, as recently reported.

45. *Dysnomia* (*Pilea*) *florentina* (Lea).—The real *florentina* only at Mussel Shoals in the lower Tennessee; reported also from Cumberland River, but this should be confirmed.

Finally there is *Actinonaias carinata gibba* (Simpson) in the Cumberland, lower and upper Tennessee. But this probably is not a typical Cumberlandian form, since it is also found in Green River, Ky., that is to say in the Ohio drainage (I have collected it myself in the vicinity of Mammoth Cave).

This completes the list of "Cumberlandian" Naiades, as far as I am able to make it out. Of the 45 forms enumerated above we may be tolerably sure, that their "center of origin" is in the Cumberland region, or some portion of it, for the reason, that at present they are restricted to it. Twenty-four species out of the 45 are found in Duck River, that is a little over half of them, 53%.

But it is quite probable, that there are other forms, which have their original home in this region; yet they have subsequently dispersed into other parts, chiefly into the Ohio system and the interior basin in general. I shall make no attempt here to single them out, because of the difficulty connected with this task.

No faunistic study is complete, unless it also discusses those forms which possibly might be present, *but have not been found*. It is clear, that it is difficult to positively assert, that a species is missing in a given region, simply because it has not been found: this may be due to accident. But when it concerns widely distributed, well-known, and easily recognizable forms, the argument of them not having been seen, attains greater force. As has been mentioned, the gravel bars of Duck River are thickly covered with dead shells. I made it a point to examine also these dead shells, and several species reported in the above list have been found only in this condition. Yet there are others, familiar to me, which I have never seen. I give here a list of the more important ones, chiefly such as might be expected in Duck River according to its size and general character. All these are species found in the interior basin, and also in the Cumberlandian region. (The Cumber-

landian types missing in the Duck are given above, Nos. 25 to 45).

Cumberlandia monodonta (Say).—Generally a rare form, frequent only in upper Tennessee. This might yet be discovered in the Duck.

Fusconaia subrotunda (Lea), and related forms.—The absence of such forms in Duck River is very striking: I have seen no trace of them.

Fusconaia flava (Rafinesque), and related forms.—Although represented in Cumberland River, and replaced, in the Tennessee by the *cuneolus* and *edgariana*-types, no trace of this group has been seen in the Duck.

Quadrula metanevra (Rafinesque).—A species easily recognized, but not seen by myself.

Plethobasus cooperianus (Green) and *Pl. cyphyus* (Rafinesque).—The genus *Plethobasus* is altogether missing.

Obovaria olivaria (Rafinesque).—Not seen.

Lampsilis orbiculata (Hildreth).—Not seen; the latter two species are rather rare, at least in the Tennessee.

Dysnomia sulcata (Lea).—An Ohio-form, going into the Cumberland and lower Tennessee (Mussel Shoals). Not seen in Duck.

Dysnomia torulosa (Rafinesque) (probably including *D. propinqua* (Lea).—In the lower Ohio drainage and in the Tennessee, up to the Knoxville region, but not known from Cumberland. Not seen in Duck River.

These forms missing in Duck River, are mostly known to be large-river-forms, some of them also entering smaller streams. Of the Cumberland types, missing in Duck River, (Nos. 25 to 45), again several are large-river-types (*Fusconaia cuneolus appressa, Fusc. edgariana, Fusc. barnesiana tumescens, Dromus dromas, Dysnomia haysiana, Dysn. biemarginata, Dysn. florentina*) while of the Cumberland types *present* in the Duck, the majority distinctly prefers small streams (*Fusconaia barnesiana bigbyensis, Lexingtonia dolabelloides conradi, Pleurobema oviforme argenteum, Lasmigona holstonia, Alasmidonta minor, Ptychobranchus subtentum, Caruculina moesta, Car. cylindrella, Conradilla caelata, Medionidus conradicus, Micromya nebulosa, Micr. taeniata, Micr. vanuxemensis, Dysnomia lenior, Dysn. turgidula, Dysn. florentina walkeri.*)

Typical *small-river-forms of the interior basin*, found in Duck River, are few: *Obovaria subrotunda lens* and *Lampsilis ovata ventricosa* could be named. (*Anodonta grandis* also be-

longs here, but this species is subject, apparently, to peculiar laws of dispersal.)

Thus it is seen, that Duck River has a *mixed fauna, consisting of two elements: a small-river-fauna,* composed largely of *Cumberlandian types* (about 38%), and an element belonging to the *interior basin* (about 62%); the latter consists chiefly of *large-river-types.* This is also shown in the percentage of Cumberlandian types present at the various stations: at Centreville, 0%; at Ben, 11%; at and above Columbia, 31%; Leftwich, 33%; Lillard's Mills, 30%; Wilhoite, 36%; Shelbyville, 41%; Normandy, 86%; Coffee County, 100%; Manchester, 100%; Riverside, 63%; Wartrace, 43% (the latter higher than Shelbyville, the next station below).

It appears that the *Cumberlandian fauna is the original fauna of Duck River,* while the interior-basin-bauna is a later invasion of the river, coming up from the lower parts; yet important elements of the interior fauna have not yet reached Duck River. In the lower Duck, at Centreville, and probably farther down, the interior fauna alone is present, and *this part does not belong to the Cumberlandian region.*

From these facts we may derive the following conclusion. *Duck River originally was more directly connected with the Cumberland and Tennessee, and, at that time, it was a rather small river. Later on, it was brought into closer and more direct connection with the interior basin, probably with the help of the lower Tennessee in western Tennessee and Kentucky,* which, of course, means a *change in the direction of the drainage.* I am not going into the details of this question, chiefly that part of it, which concerns the old connections of Duck River, and the direction of its flow, except that I repeat, what I have just said: *it must have been more closely and directly connected, with both Cumberland and Tennessee.*

At the present time, the *distribution of the Cumberlandian Naiad fauna is markedly discontinuous,* being found in the upper Cumberland, the upper Duck, and the Tennessee above the Mussel Shoals, but *not* in the *lower* Cumberland, the *lower* Duck, and probably also the *lower* Tennessee (downward from some point below the Mussel Shoals, which has not yet been ascertained.)

The present paper has been published with the purpose of furnishing material for the solution of the above question, which is intimately connected with the general problem of the history of the Tennessee-Cumberland systems, and their relation to the adjoining drainages, chiefly also that of the Alabama River. My first contribution toward this aim is the paper on the upper Tennessee shells, frequently referred to above, and additional material will be found in the series of papers on Naiades from the Gulf drainage, published recently in the "Nautilus" (Naut. 35. '23 p. 73 ff., p. 129 ff., and 37, '23 p. 56 ff.).

Carnegie Museum.

The American Midland Naturalist

PUBLISHED BI-MONTHLY BY THE UNIVERSITY
OF NOTRE DAME, NOTRE DAME, INDIANA

VOL. IX. MARCH, 1924. NO. 2

The Birds of Floyd County, Iowa.

CARROLL LANE FENTON.

IV.—SPECIAL TABLES AND DISCUSSIONS; BIBLIOGRAPHY, PLATES.

TABLE I.

SPRING MIGRATION RECORD OF THE AUTHOR, 1917.

(*Jan. 1 to June 13*)

Name of Bird	When First Seen	About How Many Seen	When Next Seen	When it Became Common	When Last Seen
Pied-billed Grebe	Apr. 19	1	May 2	May 25	
Black Tern	May 23	1	May 24		May 25
Forster's Tern	May 1	8	May 2		May 2
Canada Goose	Mar. 26	6			Mar. 26
Bittern	May 15	1	May 30	May 30	
Least Bittern	May 24	1	May 30	May 30	
Great Blue Heron	May 28	1			
Little Green Heron	Apr. 19	1	May 15	May 15	
Black-crowned Night Heron	May 1	1	June 12	June 12	
Virginia Rail	May 24	1			May 24
Sora	Apr. 19	1	May 15	May 24	
Florida Gallinule	May 6	1	May 24	May 24	May 27
Coot	Apr. 15	1	May 24	May 24	
Woodcock	May 28	1			May 28
Wilson's Snipe	Apr. 2	1	Apr. 15	Apr. 29	May 6
Little Blue Heron (?)	June 12	1			
Yellowlegs	June 12	1	June 14	June 12 (?)	
Greater Yellowlegs	June 12	3	June 14	June 12	
Upland Plover	June 12	4	June 13	June 12	
Spotted Sandpiper	Apr. 15	2	May 15	May 15	
Killdeer	Mar. 21	1	Mar. 22	Mar. 22	
Mourning Dove	Apr. 2	2	Apr. 11	Apr. 12	
Marsh Hawk	Apr. 12	2	June 18	June 21	
Sharp-shinned Hawk	Apr. 19	1	Apr. 24		
Cooper's Hawk	Apr. 11	1	Apr. 19		
Red-tailed Hawk	Mar. 18	2	Mar. 25	Mar. 25	
Red-shouldered Hawk	Mar. 14	3	Mar. 18	Mar. 18	
Broad-winged Hawk	Mar. 22	1	Apr. 3	Apr. 11	
Pigeon Hawk	Apr. 12	1			

Name of Bird	When First Seen	About How Many Seen	When Next Seen	When it Became Common	When Last Seen
Sparrow Hawk	May 27	2	June 2		
Barred Owl	Feb. 3	2	Feb. 16		
Screech Owl	Jan. 7	1	Jan. 8		
Black-billed Cuckoo	June 10	2	June 11	June 12	
Yellow-billed Cuckoo	June 10	1	June 11	June 12	
Belted Kingfisher	Mar. 25	1	Apr. 2	Apr. 2	
Hairy Woodpecker	Jan. 2	4	Jan. 6	Jan 2	June 8
Northern Hairy Woodpecker (?)	Feb. 9		Mar. 2	Mar. 2	May 27
Downy Woodpecker	Jan. 3	2	Jan. 5	Jan. 3	May 24
Yellow-bellied Sapsucker	Apr. 5	1	Apr. 12	Apr. 5	
Red-headed Woodpecker	Jan. 2	4	Mar. 2	Mar. 2	
Northern Flicker	Mar. 25	1	Apr. 2	Apr. 12	
Whip-poor-will	June 20	1			
Nighthawk	May 15	1	May 16	May 31	
Chimney Swift	May 4	4	May 5	May 20	
Ruby-throated Hummingbird	May 22	1	June 8		
Kingbird	May 20	1	May 24	May 31	
Phoebe	Apr. 5	4	Apr. 9	Apr. 9	
Wood Pewee	May 6	3	May 9	May 6	
Acadian Flycatcher (?)	May 24		May 25	May 24	May 27
Prairie Horned Lark	Apr. 2	3	May 6	Apr. 2	
Hoyt's Horned Lark (?)	May 6	2	June 8	June 8	
Blue Jay	Jan. 3	2	Jan. 1	Jan. 3	
Crow	Jan. 2	5	Jan. 10	Jan. 2	
Bobolink	Apr. 29	1	May 7	June 8	
Cowbird	Mar. 25	1	Apr. 18	Apr. 19	
Yellow-headed Blackbird	June 10	3			June 10
Red-winged Blackbird	Mar. 22	10	Mar. 24	Mar. 24	
Meadowlark	Mar. 20	1	Mar. 21	Mar. 30	
Western Meadowlark	Mar. 26	1	Mar. 27	Mar. 27	
Orchard Oriole	May 16	1	May 22	May 22	
Baltimore Oriole	May 12	2	May 13	May 13	
Rusty Blackbird	Apr. 15	4	May 1	May 1	
Brewer's Blackbird	Apr. 12	6	May 1	Apr. 12	
American Goldfinch	May 13	3	May 14	May 13	
Snow Bunting	Mar. 21	1			Mar. 21
Vesper Sparrow	Apr. 12	23	Apr. 13	Apr. 13	
English Sparrow	Jan. 1	8	Jan. 2	Jan. 1	
Savannah Sparrow	Apr. 12	3	Apr. 15	Apr. 15	
Grasshopper Sparrow	Apr. 5	4	Apr. 6	Apr. 5	
Harris' Sparrow	Apr. 15	2	Apr. 16	Apr. 16	
White-crowned Sparrow	Apr. 12	12	Apr. 15	Apr. 12	May 25
White-throated Sparrow	Apr. 15	14	May 1	May 1	
Tree Sparrow	Jan. 6	6	Jan. 14	Jan. 6	
Field Sparrow	Apr. 19		Mar. 24	May 24	
Slate-colored Junco	Feb. 22	2	Mar. 10	Mar. 10	May 13
Chipping Sparrow	Apr. 2	18	Apr. 5	Apr. 2	
Song Sparrow	Apr. 2	40	Apr. 4	Apr. 2	
Swamp Sparrow	Apr. 2	6	Apr. 12	Apr. 19	May 27
Fox Sparrow	Apr. 12	6	May 27	Apr. 12	May 27
Cardinal	May 27	1			May 27
Rose-breasted Grosbeak	Apr. 15	1	May 15	May 16	

Name of Bird	When First Seen	About How Many Seen	When Next Seen	When it Became Common	When Last Seen
Indigo Bunting	June 21	1			
Dickcissel	Mar. 25	3	Apr. 2	Apr. 2	
Scarlet Tanager	May 25	1	May 27	May 27	
Purple Martin	Apr. 24	7	Apr. 26	Apr. 24	
Cliff Swallow	May 24	12	May 27	May 24	
Barn Swallow	Apr. 26	23	Apr. 29	Apr. 26	
Tree Swallow	Apr. 26	37	Apr. 29	Apr. 26	
Rough-winged Swallow	Apr. 26	8	May 1	May 1	
Bohemian Waxwing	June 8	4			
Henslow's Sparrow	Apr. 2	6	Apr. 6	Apr. 2	Apr. 6
Migrant Shrike	June 12	7	June 18	June 12	
Red-eyed Vireo	May 6	1	May 20	May 20	
Warbling Vireo	May 6	1	May 27	May 27	
White-eyed Vireo	May 15	2	May 20	May 24	
Black and White Warbler	May 24	2	May 26	May 26	
Prothonotory Warbler	May 15	2	May 16	May 16	
Tennessee Warbler	May 6	1			May 6
Yellow Warbler	May 15	1	May 16	May 16	
Myrtle Warbler	Apr. 16	3	Apr. 22	Apr. 24	May—
Magnolia Warbler	Apr. 16	4	Apr. 28	May 1	
Blackburnian Warbler	May 22	7	May 27	May 22	May 27
Black-throated Green Warbler	May 6	1			May 6
Ovenbird	May 15	1	May 16	May 24	
Louisiana Waterthrush	May 15	28	May 16	May 15	
Grinnell's Water-thrush	May 24	6	May 26	May 24	
Connecticut Warbler	May 20	1	May 24	May 24	
Mourning Warbler	May 25	1			May 25
Maryland Yellowthroat	May 15	3	May 16	May 20	
Canadian Warbler	May 22	18	May 23	May 22	June 8
American Redstart	May 15	2	May 25	May 25	
Catbird	Mar. 25	1	May 15	May 15	
Brown Thrasher	Apr. 26	1	May 1	May 15	
Bewick's Wren	May 15	1			May 15
House Wren (Western)	May 7	2	May 10	May 10	
Carolina Wren	Apr. 19	1			Apr. 19
Short-billed Marsh Wren	May 20	2	June 12		
Brown Creeper	Jan. 5	1	Feb. 13	Jan. 5	
Chickadee	Jan. 2	4	Jan 2	Jan. 3	
Long-tailed Chickadee	Jan. 2	2			Jan 2
Golden-crowned Kinglet	Apr. 5	4	Apr. 10	Apr. 5	May 10
Ruby-Crowned Kinglet	Apr. 2	13	Apr. 5	Apr. 5	May 11
Wood Thrush	Mar. 30	1	May 2	May 2	
Veery	Apr. 12	2	Apr. 23	May 16	
Olive-backed Thrush	Apr. 12	1			Apr. 12
Hermit Trush	Apr. 2	6	Apr. 12	Apr. 12	Apr. 24
Robin	Mar. 14	1	Mar. 16	Mar. 16	
Bluebird	Mar. 13		Mar. 14	Mar. 14	

TABLE 2.

WINTER BIRDS OF FLOYD COUNTY.

A—RESIDENTS.

SPECIES	Nov.	Dec.	Jan.	Feb.
Bobwhite	x	x	x	x
Ruffed Grouse	x	x	x	x
Prairie Chicken	x	x	x	x
Wild Turkey	?	x	x	x
Bald Eagle *	x	x	?	
Long-eared Owl	x	?	x	x
Short-eared Owl	x	x	x	x
Barred Owl	x	x	x	x
Screech Owl	x	x	x	x
Great Horned Owl	x	x	x	x
Hairy Woodpecker	x	x	x	x
No. Downy Woodpecker	x	x	x	x
Redheaded Woodpecker	x	x	x	x
Blue Jay	x	x	x	x
Crow	x	x	x	x
Goldfinch	x	x	x	x
Cardinal		x	x	
Northern Shrike	x	x	x	x
Brown Creeper	x	x	x	x
White-breasted Nuthatch	x	x	x	x
Chickadee	x	x	x	x

* Probably now a winter resident.

B—WINTER RESIDENTS.

SPECIES	Nov.	Dec.	Jan.	Feb.
Goshawk *	x	x	?	
Golden Eagle	x	x	x	
Snowy Owl	x	x	x	x
Tree Sparrow	x	x	x	x
Slate-colored Junco	x	x	x	x
Red-breasted Nuthatch	x	x	x	x

* Perhaps a late migrant.

C—WINTER VISITANTS.

SPECIES	Nov.	Dec.	Jan.	Feb.
Sawwhet Owl	x		x	
Pine Grosbeak	?	x	x	x
Crossbill		x	x	x
Redpoll	x	x		
Pine Siskin	x	x	?	

D—MIGRANTS.

SPECIES	Nov.	Dec.	Jan.	Feb.
Yellow-bellied Sapsucker	x			x
Cedar Waxwing	x	?		
Bluebird	x			x
Golden-crowned Kinglet	x			x

E—SUMMER RESIDENTS, OCCASIONALLY REMAINING IN WINTER.

SPECIES	Nov.	Dec.	Jan.	Feb.
Belted Kingfisher	x	x		?
Phoebe	x	x	?	
Western Meadowlark	x	x		x
Robin	x	x	x	x

THE RAPTORES.

Of the 100 species of Raptores given in the 1910 Checklist of the American Ornithologists' Union as occurring north of the Mexican boundary in North America and Greenland, 309 occur in Iowa.* To this list one subspecies is to be added, the Iowa Broadwinged Hawk of Bailey (Rapt, Bds. Ia., 1918, 130),

* Data on Raptores of the state taken from Bailey's "The Raptorial Birds of Iowa," Bull. 6, 1918, Iowa Geological Survey.

making a total of 101 for North America and 40 for the state of Iowa. The species and subspecies are distributed as follows:

	Iowa	Floyd County	N. A.
Vultures	3	1	3
Hawks	27	16 (17?)	54
Owls	12	8	44
	40	25 (26?)	101

Percent for state 62.5

Percent for N. A. 24.75

This relatively large percentage is probably largely due to the great changes of temperature, which allows for both northern and southern forms. It is also to be noted that in the 4th. Provisionel Map of the Biological Survey, 1910, Merriam puts some two-thirds of Cerro Gordo, most of Mitchell, and the northwestern part of Floyd counties in the Transition zone. The balance of Cerro Gordo and Floyd counties, and all of Chickasaw County, are in the Upper Austral zone. This condition probably aids in the relatively large representation of the raptorial avifauna.

In the following table the raptorial birds of Floyd County are listed. From left to right, the list is divided in accordance with the habitat of the birds; from top to bottom in accordance with their region of greatest abundance.

SYMBOLS.

* Nesting. ** Permanent resident.
§ Occurring in winter; usually a winter resident.
‡ Occasional in winter. † Migrant.
c Common. tc Tolerably common.
u Uncommon. r Rare.
rr Very rare.

NOTE:—Above symbols refer to Table 3 on following page.

TABLE III.

RAPTORIAL BIRDS OF FLOYD COUNTY.

	Species preferring Timbered Regions.	Species frequenting both Timber and Prairie	Species preferring Prairie Regions.
A	†‡Goshawk (r)		§Snowy Owl (r) Hawk (u) §Rough-legged
B	*Red-shouldered Hawk (tc) *Broad-winged Hawk Bald Eagle **Barred Owl (c) **Great Horned Owl (u)	*Sparrow Hawk (c) *‡Red-tailed Hawk (tc)	
C	Swallow-tailed Kite (rr) *Sharp-shinned Hawk (c) *Cooper's Hawk (c) *Barn Owl (r)	‡*Turkey Vulture (r)	
D	Duck Hawk (?) *Long-eared Owl (u) ‡Sawlwhet Owl **Screech Owl (c)	†Pigeon Hawk (u) †Osprey (r)	*Marsh Hawk (c) *Short-eared Owl. (c)
E		*Krider's Hawk (tc) Swainson's Hawk (u) §Golden Eagle (u)	
	Total 13 (&1?)	Total 8	Total 4

A.—Area of greatest abundance Northward, coming south in winter.

B.—Area of greatest abundance Eastward, extending westward.

C.—Area of greatest abundance Southward, coming north in summer.

D.—Area of greatest abundance Iowa or contiguous states, or as abundant there as elsewhere.

E.—Area of greatest abundance Westward, extending eastward.

Local Names of Birds, in Use in or Near Floyd County.

In my study of the birds of the county I have given some attention to the common or local names by which they are known. With a few exceptions the names do not seem to be restricted to this district; most of them are the common names by which the birds are known throughout the middle west.

Most of the birds are without popular names of any sort. The Indigo Bunting, for example, is known by name—any name—to a very small percentage of the people. All gulls, if recognized at all, are merely "gulls," all sparrows are "sparrows." Such lump classifications are not considered here.

COLYMBIDAE.

Podilymbus podiceps (Linn.). Diving Duck, Hell Duck, Hell Diver, Little Diver, Little Grebe.

GAVIIDAE.

Gavia immer (Brunn.). Hell Diver, Great Diver, Northern Diver, Black-and-white Diver, Big Diver.

PELECANIDAE.

Pelecanus erythrorhynchos Gmel.. Pelican, Yellow-billed Pelican.

ANATIDAE.

Mergus americanus (Cass.). Fish Duck.
Lophodytes cucculatus (Linn.), Fish Duck, Sheldrake.
Spatula clypeata (Linn.). Sheldrake.
Charitonetta albeola (Linn.). Butterball.
Chen caerulescens (Linn.). Black Goose (applied to young).

ARDEIDAE.

Botaurus lentiginosus (Mont.). Mud-pump, Mud-pumper, Sheitpoke.
Ixobrychus exilis (Gmel.). Sheitpoke, Snipe, Fly-up-the-creek.
Ardea herodias herodias Linn. Blue Crane, Sandhill Crane, Sheitpoke.
Butorides virescens virescens (Linn.). Sheitpoke, Mud Chicken.

Nycticora nycticora naevius (Bodd.). Blue Crane, Blue Heron, Sheitpoke (young).

RALLIDAE.

Rallus elegans Aud. Sheitpoke, Mud Chicken, Mudhen.

Rallus virginianus Linn. Sheitpoke, Mud Chicken, Mudhen.

Porzana carolina (Linn.). Sheitpoke, Little Sheitpoke Crake.

Gallinula galeata galeata (Light.). Coot, Mudhen, Waterhen.

Fulica americana Gmel. Mudhen, Waterhen, Swamp Hen, Black Mudhen.

SCOLOPACIDAE.

Gallinago delicata (Ord.). Snipe, Jacksnipe, English Snipe, Little Sheitpoke.

Totanus melanoleucus (Gmel.). Sheitpoke, Snipe, Stilt, Yellowshank.

Totanus flavipes (Gmel.). Sheitpoke, Little Sheitpoke, Snipe.

CHARACRIIDAE.

Oxyechus vociferus vociferus (Linn.). Plover, Kildee.

TETRAONIDAE.

Colinus virginianus virginianus (Linn.). Quail, Partridge.

Bonasa umbellus umbellus (Linn.). Partridge, Woodhen, Woodcock.

Tympanuchus americanus americanus (Reich.). Prairie Hen.

COLUMBIDAE.

Ectopistes migratorius (Linn.). Wild Pigeon, Pigeon.

Zenaidura macroura carolinensis (Linn.). Turtle Dove, Pigeon.

CATHARTIDAE.

Cathartes aura septentrionalis (Wied.). Buzzard, Turkey Buzzard, Black Buzzard.

BUTEONIDAE.

Circus hudsonicus (Linn.). Chicken Hawk, Hen Hawk, Blue Hawk.

Accipiter velox (Wils.). Chicken Hawk, Hen Hawk, Pigeon Hawk.

Accipiter cooperi (Bonap.). Chicken Hawk, Hen Hawk.

Buteo borealis borealis (Gmel.). Chicken Hawk, Hen Hawk.

Aquila chrysaetos (Linn.). Chicken Hawk, Hen Hawk, Eagle Black Eagle.

STRIGIDAE.

Asio wilsonianus (Less.). Screech Owl, Hoot Owl, Cat Owl.

Asio flammeus (Pont.). Screech Owl, Ground Owl, Swamp Owl.

Strix varia varia Barton. Hoot Owl.

Otus asio asio (Linn.). Hoot Owl, Little Owl (rare).

Bubo virginianus virginianus (Gmel.). Hoot Owl, Cat Owl.

Nyctea nyctea (Linn.). White Owl, Hoot Owl, Northern Owl.

CUCULIDAE.

Coccyzus erythropthalmus (Wils.). Rain Crow, Squouk (pron. 'skwouk').

Coccyzus americanus americanus (Linn.). Rain Crow Squowk.

PICIDAE.

Dryobates villosus villosus (Linn.). Sapsucker, Big Sapsucker, Spotted Woodpecker.

Dryobates pubescens medianus (Swains.) Sapsucker, Spotted Woodpecker.

Colaptes auratus lutens (Bangs.). Yellowhammer, Yellow-winged Woodpecker, Golden-winged Woodpecker, High-hole, High-holder, Whickaree, Ant Woodpecker.

TYRANNIDAE.

Tyrannus tyrannus (Linn.). Bee Martin, Bee Bird.

CORVIDAE.

Cyanocitta cristata cristata (Linn.). Jay, Jay-bird.

ICTERIDAE.

Molothrus ater ater (Bodd.). Cow Blackbird, Blackbird.

Quiscalus quiscula aeneus Ridgway. Blackbird, Crow, Blackbird, Crowbird.

FRINGILLIDAE.

Astragalinus tristis tristis (Linn.). Canary, Wild Canary.
Spizella passerina passerina (Bech.) Chippy.
Junco hyemalis hyemalis (Linn.). Snowbird.
Plectrophenax nivalis (Linn.). Snowbird.

TANAGRIDAE.

Piranga erythromelas Vieill. Tanager, Redbird.

LANIIDAE.

Lanius ludovicianus migrans Palmer. Butcher Bird, Killer Bird.

MIMIDAE.

Toxostoma rufum (Linn.). Brown Thrush, Spotted Thrush, Thrasher-bird.

TROGLODYTIDAE.

Troglodytes aëdon parkmani (Aud.). Jenny Wren.

SITTIDAE.

Sitta carolinensis carolinensis Lath. Creeper, Sapsucker, Devil Downhead.
Sitta canadensis Linn. Creeper, Sapsucker, Devil Downhead.

TURDIDAE.

Hylocichla mustelina (Gmel.). Bell Bird.
Hylocichla guttata pallasi (Cab.). Bell Bird, Brown Thrush.

BIBLIOGRAPHY.

Anderson, Rudolph Martin. The Birds of Iowa. Proc. Davenport Acad. Sci., XI, pp. 125-417, Davenport, 1907.

Bailey, Bert Heald. (Clementina Spencer, ed.) The Raptorial Birds of Iowa. Ia. Geol. Surv., Bull. 6, Des Moines, 1918.

Two Hundred Wild Birds of Iowa, Cedar Rapids, 1906.

Califor Naturalist Club. First, second, and third annual reports: bird lists by members. Charles City, 1916, 1917, 1918.

Bulletin, vol. I., no. 1. Charles City, May, 1916.

Fenton, Carroll Lane. Nesting of the Mountain Bluebird at Charles City, Bull. C. N. C., vol: I. no. 1.

Preliminary List of the Birds of Floyd County, Iowa, (incomplete), Wilson Bulletin, no. 96, pp. 130-138, Oberlin, 1916.

Gabrielson, Ira N. A Criticism of Two Recent Lists of Iowa Birds. Wilson Bulletin, No. 99, pp. 97-100, Oberlin, 1917.

Keyes, Charles Rollin, and Williams, H. S. Preliminary Annotated Catalogue of the Birds of Iowa. Proc. Davenport Acad. Nat. Sci., V, pp. 113-161, Davenport, 1888.

Krider, John. Forty Years' Notes of a Field Ornithologist, 1879.

Page, Mrs. A. G. From a Kitchen Window; Beyond the Window, The Prairie, I, pp. 10-11. Charles City, Jan. 1921.

Webster, Clement L. History of Floyd County, Charles City, 1896.

Albinism in Iowa, Iowa Naturalist, II, p. 38, Iowa City, 1909.

The Whip-poor-will in Floyd County, Bull. C. N. C., I, Charles City, 1916.

CORRECTION.

In the second instalment of this paper (Am. Mid. Nat., vol. VIII, Nos. 10-11) there are two typographical errors. Thus on page 236 (for the line "16 *Sturnella neglecta* Aud. Western Meadow Lark" read "125, *Sturnalla magna magna* (Linn.). Meadow Lark." Page 251, for "208. *Dumetella carolinensis*" read "209. *Dumetella carolinensis.*"

KEY TO SPECIES.

67—Kildeer.
90—Sparrow Hawk.
106—Redheaded Woodpecker.
108—Northern Flicker.
111—Chimney Swift.
113—Kingbird.
115—Phoebe.
116—Wood Pewee.
118—Blue Jay.
120—Crow.
124—Red-winged Blackbird.
125—Meadow Lark.
126—Western Meadow Lark.
128—Baltimore Oriole.
136—Goldfinch.
151—Chipping Sparrow
162—Dickcissel.
163—Scarlet Tanager.
168—Bank Swallow.
187—Yellow Warbler.
209—Catbird.
210—Brown Thrasher.
227—Robin.

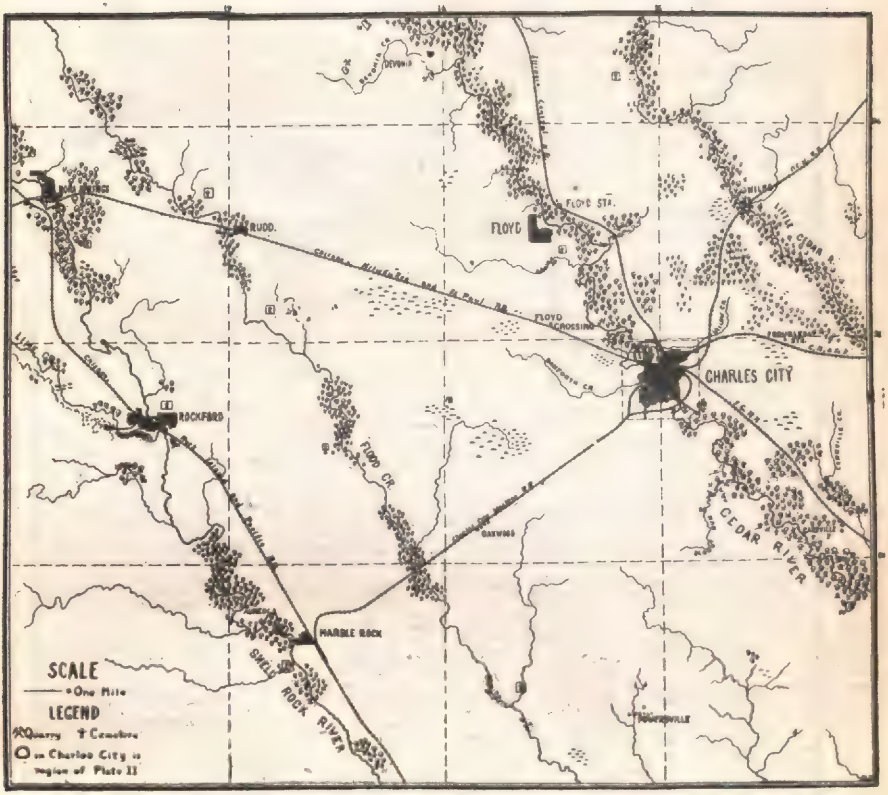


PLATE I.

Sketch map of Floyd County, Ia. Conventional signs for woodlands and swamps; dotted woodlands indicate areas with much undergrowth. Open areas mainly cultivated prairies, with some pasture land. Area of Plate II indicated by heavy line.

ILL. CENT.
C.M.&St.P.

PLATE II.

Map of outskirts of the northwestern part of Charles City, showing nesting records for 1915-1918, inclusive. The district in the lower right hand corner of the map (south of C. M. & St. R. railway tracks and east of Kellogg Ave.) is so closely built as to make representation of houses undesirable; trees too are plentiful. For this district the nesting records are incomplete; the others indicate field work from two to six times weekly throughout the breeding season.

The numbers indicate the species of birds, and coincide with those used in the general list, though a special list of the species found nesting in the area shown is given below. An asterisk preceeding the number (i. e, *148) indicates a nest actually observed and plotted: the number alone indicates either: nest seen but exact location not plotted upon observation, or record based on sight of adult male early in morning during breeding season. For general location of the area, see Plate 1, where it is indicated.

On Premedical Education with Especial Reference to the Viewpoint of Class A Medical Schools.*

N. M. GRIER, PH. D.

Courses in pre-medical education as at present outlined by most Colleges and Universities cover in a period of two years the minimum requirements for admission to acceptable medical schools, which total 60 semester hours of collegiate work exclusive of military and physical education. In detail these requirements as set forth by the American Medical Association are as follows (†):

Required Subjects.

Chemistry	12 hrs.
Physics	8 hrs.
Biology	8 hrs.
English Composition and Literature	6 hrs.

As subjects strongly urged to total the 60 sem. hrs. are indicated,

Modern foreign language	6-12 hrs.
Advanced Botany or Advanced Zoology	3-6 hrs.
Psychology and Logic	3-6 hrs.
Advanced Mathematics, including Higher Algebra and Trigonometry	3-6 hrs.
Additional Courses in Chemistry	3-6 hrs.

The medical schools at large have usually insisted upon the minimum requirements being taken in a period of two or three years of college work with other subjects the student may elect, with or without proper guidance.

Without indicating the period to be spent in their study, the Association suggests other electives also, presumably as they can be taken in the two year premedical course viz., additional English, Economics, History, Sociology, Political Science, Mathematics, Greek, Latin, Drawing. Un-

* Paper read before Section F., A. A. A. S. and American Society of Zoologists, Dec. 27, 1923, Cincinnati, Ohio.

† "Choice of a Medical School." 1923. American Medical Association.

less it is felt that the subjects strongly urged or suggested should govern the students choice of electives where he can devote more than two years to preparation for medical school, the remaining work of a four year pre-medical course is largely unsettled except in the case of Chemistry, where three or four years work in that subject may be required by certain medical schools. Occasionally suggestions as to other electives are found, but the fact remains that very few Colleges or Universities have a definitely organized four year pre-medical course although such would be an advantage both for them and for students desiring a prolonged period of instruction, as data presented later will indicate.

In an effort to otbain opinion further defining the scope of pre-medical education already discussed, as well as to secure some basis for the formulation of the same in its best and broadest terms, a questionnaire was sent to the Deans of Class A Medical Schools. These physicians would be expected to be familiar with the defects of present day medical students, and would presumably have some vision of the needs, especially social ones, which future physicians should be able to fill with some regard to conserving the ideals of the profession. So far as premedical education could be considered to meet these needs, they were to indicate on the questionnaire which included a list of the subjects composing the curriculum of a typical College of Arts and Sciences, (as hereafter given in the results presented), and on which the Deans might check all subjects believed to be of broad yet practical interest to the future physician. They were asked to indicate as a maximum where they could, the approximate time such subjects were to be pursued. The subjects of Biology and Chemistry were presented in an expanded form for the stated purpose of learning the division of the subject most favored a given institution in interpreting, (1) the requirements of the A. M. A., (2), the requirements of admission to the school concerned; (3), advisory electives not covered by 1 or 2. In view of the fact that medicine is fundamentally biological and chemical in nature, the Deans were also asked to check the divisions of these latter subjects, which in their opinion, enabled the student to make better progress in medical school, especially those helping him

to perform or assist in research. If the list of the subjects appeared incomplete, they were requested to add such others as they pleased at the end of the questionnaire, and in the case of general titles such as Economics, Psychology, etc., to specify the division of the subject they preferred. Such additions are expressed in *italics*.

The following table represents the choice of the subjects approved by these officials, and since a majority of the Deans, (47 of 68 Class A Medical Schools), responded, may be considered fairly representative of opinion. It thus may be useful for provoking further discussion, if not for Colleges planning a definite four year pre-medical course. All subjects, except those indicated in the *minimum* requirements of the Association, are expressed as electives, except where afterwards in discussion some official emphasizes their positive need.

TABLE 1.

Subject	Desired	Not Desired	Doubtful	Do Not State
Accounting	1	2		44
Astronomy	1	2		44
Bible	2	4		41
BIOLOGY				
½ yr. Zoology and ½ yr. Botany	31			
High School Biology	1			
½ yr. Zoology alone	4			
Invertebrate Zoology	27	1		29
Comparative Anatomy	35			12
Histology & Microtechnique	10	7		30
Cytology	1			46
Embryology	20	3		24
Heredity and Eugenics	20	2	1	24
Botany	10	3		34
Bacteriology	6	7	1	33
CHEMISTRY.				
General	47			
Qualitative	34			13
Quantitative	28			19
Organic	47			
Physical	27	2		18
Industrial	1			46
Physiological	1	11		36

Civics	1			46
Composition	27			20
Drawing, Free-hand	3			44
Economics	28	1		18
Education	1	3		43
English	37			
Ethics	11	2		34
French	41			6
German	40			7
Geology	8	3		36
Geography	1	3		43
Greek	7	4		36
History	24	1	1	21
Hygiene	8	2		37
Italian	5	3		39
Latin	13			34
High School Latin	8			39
Logic	3			44
Mathematics	28	1		18
Philosophy	10	2		35
Physics	47			
Physiology, Human	4	2	2	39
Physiology, Comparative	1	3		43
Political Science	12	1		34
Psychology	35			12
Public Speaking	1			46
Sociology	27			20
Spanish	7	3	1	46
Statistics	5	4	1	37

DISCUSSION OF SUBJECTS INDICATED IN TABLE 1.

In the following, it is proposed to amplify those subjects given above concerning which divergent opinion brings out points of interest, or which clearly have some function in premedical education. For such reasons, subjects for which a smaller number of preferences were given, such as Astronomy, Accounting etc., are not discussed.

BIOLOGY AND THE MINIMUM BIOLOGY ENTRANCE REQUIREMENT.

Here the outstanding preference is evidently for the *content* of the old-fashioned Biology course, consisting of one-half Zoology and one-half Botany, the range of time embraced, specified as General Biology being from 4-8 sem. hrs. However,

important institutions react differently and in line with the alternate year of Zoology only as indicated in the A. M. A. requirements. Indiana, George Washington, St. Louis, Emory, Minnesota, Oregon, Mississippi and Cornell unite in preferring 4 sem. hrs. of Invertebrate Zoology and 4 sem hrs. of Vertebrate oZology. The latter is usually taught from the laboratory standpoint as Comparative Anatomy. Nebraska qualifies this year of strict Zoology by specifying Medical Zoology, Parasitology and Vertebrate Zoology as the subject to be taken. Western Reserve accepts either Biology or the pure Zoology. Johns Hopkins, Stanford and Harvard believe that the minimum entrance requirement should consist of Zoology, Comparative Anatomy and Embryology; California, General Zoology and Embryology. Yale makes up the minimum requirement somewhat similarly. Loyola indicates a course in Comparative Anatomy and the Histology of elementary tissues, following and entrance requirement of High School Biology. Creighton desires 1 hr. of Invertebrate Zoology, 3 hrs. of Vertebrate, 1 of Heredity and Eugenics, 2 of Botany. Pennsylvania gives 3 hrs. of General Biology, 3 of Invertebrate Zoology, 3 of Comparative Anatomy.

INVERTEBRATE ZOOLOGY.

The range of instruction in this subject regardless of the combination is from 3 mos. to 1 year in time, with most preferring 4 sem. hours. The following institutions indicate work in it beyond General Biology; which it usually follows in the curriculum; Stanford Yale, Tufts, N. Dakota, Jefferson, Pennsylvania, Pittsburgh, Texas, W. Virginia, Chicago.

COMPARATIVE ANATOMY.

The institutions just named also indicate this subject to follow Invertebrate Zoology. The range of the instruction recommended varies from 3 mos. to a year, 4 sem. hrs. and ½ year being most common. Loyola, Boston, Western Reserve, Dartmouth, Cincinnati, Womens Medical and Wisconsin evidently desire this subject to follow General Biology.

HISTOLOGY AND MICROTECHNIQUE.

More institutions definitely desire this course than those which do not. Two semester hrs. is the maximum time; ½ hr. the minimum. As a part of the questionnaire, inquiry was made as to the conditions under which this subject would be credited in the curriculum of the Medical Schools. Eight indicated that it would be given credit when the work was of the same grade, based upon human or mammalian material, and when the student passed an examination in the subject. Even then, most of these thought that the student should do advanced work in the subject, but that may be due in part to the difficulty of obtaining a satisfactory schedule for the student. Cases are known where students thus qualified for entrance, have been made temporary laboratory assistants in the subject in an effort at equable adjustment. Five definitely state that credit will not be allowed under any condition, reminding that the Association of American Medical Colleges does not allow time credited for work done in a College of Arts and Sciences.

EMBRYOLOGY.

The time recommended for this course ranges from 3 mos. to 1 yr., free or in combination with other courses, 2-4 sem. hrs. being most popular. Western Reserve suggests a combination course of this subject with elementary mammalian anatomy. Yale, Stanford, California, Illinois, Tufts, Minnesota, St. Louis indicate it to be taken at some time, as well as Histology. An equal number—Tulane, Dartmouth, N. Dakota, Cincinnati, Oregon, Texas and Wisconsin do not desire it. Twice as many prefer it as do Histology. Embryology of lower forms than mammals is suggested by others. It developed that five of the Medical Schools would accept it for credit under cnoditions described for credit in Histology; three would not under any circumstances. One states that credit will be given for elementary Embryology in Medical School, but the student must select further work in the human study. Still another remarks that the student will be excused from this subject in Medical School and gives no further qualification. Four indicate it definitely as an elective, others state

it as being desirable. The relation of these last two subjects to future medical education will be brought out later.

HEREDITY AND EUGENICS.

The large number indicating this subject must be a source of gratification to Biologists at large in times when physicians of an older generation reiterate, against the burden of scientific evidence, their belief in prenatal influences, the transmission of acquired characters, etc. A physician with some training in this subject will be in a position to exert a greater socializing influence in his community.

BOTANY AND BACTERIOLOGY.

Botany where desired as an elective is indicated from ½ sem. hr. to 4 sem. hrs. as a minimum time. More do not desire Bacteriology; those who wish it, suggest ½ yr. or 2 sem. hrs. work in it. Bacteriology is a subject which under suitable qualification might be transferred from Medical Schools to Colleges of Arts and Sciences.

REMARKS ON BIOLOGY AS A PRE-MEDICAL SUBJECT.

There is some disagreement as to the part which Biology should generally play in premedical education. One Dean, a member of the A. M. A. committee which formulated the minimum entrance requirements, states that while Biology is highly desirable it is not essential, since the medical course itself will give the biological viewpoint. His contention is chiefly based on the supposed fact that lack of Biology may prevent certain students who are late in commencing their medical studies, from qualifying for entrance, since such men usually have the minimum requirements in other subjects. However, the evidence is that collegiate biological courses are increasing in numbers, and the content of the letter discussing the preceding question indicates that Biology should be the major in a four year premedical course, an opinion which three other Deans definitely state, and many indicate from their choice of the list of electives. One writes "I would make the work in Biology the major study in the premedical course using Biology in a wide sense, perhaps having parallel courses

in sub-divisions, in order to get more than two years work in Biology in the two years required premedical work." The Dean of another school comments upon the almost complete lack of correlation of the clinical and laboratory subjects, and states that placing certain medical subjects in the college premedical work may help correlate them better, adding that the knowledge acquired during pre-clinical years should be better applied than at present. He complains that at present much of the work is memorized until examinations are passed, and can not later be applied.

MINIMUM GENERAL CHEMISTRY ENTRANCE REQUIREMENT.

As returned in the questionnaire, this ranges from 4-10 hrs. credit, the majority favoring 8 hrs. Seven state it may include qualitative Analysis. Howard and Cornell indicate that it must. Yale gives somewhat less General Chemistry, making up the requirement in Qualitative and Quantitative Chemistry.

MINIMUM ORGANIC CHEMISTRY ENTRANCE REQUIREMENT.

Most of the schools desire a 4 hr. course, although 6-8 hrs. is the average, the time indicated being from ½-1 year. Some would like to see more Organic Chemistry required for entrance, the necessary Qualitative Analysis being in General Chemistry.

QUALITATIVE ANALYSIS.

Two believe that instruction in this subject should be combined with General Chemistry, the time to be consumed varying from 2-5 sem. hrs. and from ¼ to 1 year. This subject is definitely required by Columbia, Cornell and Johns Hopkins.

QUANTITATIVE ANALYSIS.

This subject may consume from 2-5 sem. hrs. and from ½ to 1 yr. in time. Most indicate two hrs. Required by Johns Hopkins and Cornell; Boston and Nebraska indicate the volumetric analysis as being preferable; Creighton thinks the subject should be included in other courses.

PHYSICAL CHEMISTRY.

The scope desired ranges from 1 unit and ½ yrs. work to 4 sem. hrs. and 1 year in the time thought adequate. The majority favor a 2-4 hr. course. St. Louis and Minnesota prefer it given in Medical School. Required by Johns Hopkins for entrance. Some who do not indicate it as an elective feel that instead of separate instruction in it, that its atmosphere should pervade the instruction in the minimum entrance requirement in Chemistry.

PHYSIOLOGICAL CHEMISTRY.

Only one medical school desires this to be part of the premedical instruction. Eleven think it should be confined to the purely medical curriculum.

REMARKS ON CHEMISTRY AS A PREMEDICAL SUBJECT.

One Dean writes "the greatest problem of our entrance requirements is in connection with Chemistry. We find that our students are unable to handle elementary chemical problems, apply simple arithmetic and simple algebra to theoretical considerations. The majority have difficulty with 8th grade arithmetic and college algebra. This is a stumbling block when they attempt to apply Chemistry to Physiology." On the other hand, another Dean states that while Chemistry is necessary, it is now emphasized too much for future practitioners in medicine, his belief being that except for some elementary courses it belongs on the specialist side of medicine. Another remarks that it is difficult to see what the quantitive analysis of iron, sulfates etc.—a common part of the Quantitative course—can best provide by way of preparation for the study of medicine.

ECONOMICS.

This subject as an elective has an indicated range from ½ yr. to 1 yr., embracing from 2-6 hrs. work. Its designation may be significantly interpreted as a desire to emphasize necessary cultural elements in premedical education.

ENGLISH LITERATURE AND COMPOSITION.

These two subjects are best discussed together. For the first, 2-12 sem. hrs. are designated the average being 8. Some indicate more than two years study of Literature, and one states it should include composition. More indicate it than Composition, which varies from 2-8 sem. hrs. with 4-6 hrs. as the average, and embracing ½ to 1 year of time. Some schools do not state their preference, but all indicate one or the other. One Dean in discussing the competency in English of the average medical student, states that if the latter is called upon to read aloud a selection of well written English, technical or othewise, he finds the average word of three or more syllables an insurmountable stumbling block. He further quotes an educator of national reputation as stating that a course in Physics to which the average student would have to devote a year of hard work, could be mastered in all its essentials in six weeks by another student of equal ability whose training in English and experience left nothing to be desired. Instruction in English literature seems to be the logical way of developing a taste for spontaneous reading on the part of the student, yet this Dean notes that few students read beyond their text book assignments. Another Dean indicates doubt concerning courses in English beyond the minimum entrance requirement, making the pointed remark that every course should be a course in English. Still another goes so far as to state that 90% of the men who have trouble with the medical course, do so because they do not know how to read or write intelligently or critically. Two and three hour courses in Literature are advocated also. There might well be a special course in this subject for professional students, instead of the general course all who elect it now take.

MODERN LANGUAGES AND THE MINIMUM MODERN LANGUAGE REQUIREMENT.

Most of the Deans desire two years study of the language elected, 6-8 sem. hrs. being the more common credit desired. Two suggest that the language be preceded by a High School course. The minimum for French is 6 sem. hrs., the maximum being a reading knowledge. For German 4-20 sem. hrs.

or a reading knowledge is wanted. Seven desire both, but German is preferred as first choice in 3 cases, French in but one. The others do not indicate a preference. One Dean cautions against more than the allotted language requirement, as certain State Boards of Medical registration object to an excess of language in pre-medical requirements. Another objects to the emphasis on foreign languages remarking that 95% of the medical graduates have no other use for it beyond satisfying the entrance requirement. It is additionally pointed out that all articles of merit in foreign languages are translated and abstracted into English, and are as quickly available to the student as they could receive the original journal of publication. This latter statement should answer the contention of other Deans that the preliminary work in modern languages gives the student access to scientific literature; not only that, the translations themselves are rendered into better English than the student himself could compose. In commenting upon this situation, still another remarks that if the present requirements prevail, the test of a foreign language should be the competency of its use, and not the time spent in failing to master it as has been the case in the past. A fourth writes that if the premedical course was three years in length he would recommend a reading knowledge of the elected language be required. Others say that if the languages have no other virtues, they are part of a liberal education, but one remarks that until we get a good method of acquisition of languages, the time spent in dabling in them, can be spent to better advantage in Biological sciences.

GEOLOGY.

This subject seems worthy of mention as one of the most cultural and broadening of subjects. Three sem. hrs. is the commonest period of study indicated in the returns.

GREEK.

Those who wish Greek indicate a 3 sem. hrs. course, but four definitely do not desire it. One asks that the course be one in the etymology of words, inasmuch as scientific terms are more frequently Greek than Latin.

HISTORY.

Most indicate 1 year of History, of from 2-6 hrs. Two desire 2 years. One prefers Ancient History, another American. One Dean speaks of the desirability of some acquaintance with general historical ideas, and favors a general survey course in History.

HYGIENE.

One year is the general indication for this subject. One thinks a general course should be given; another emphasizes personal disease. Is there any good reason why this subject where continued as such in the medical curriculum should not be transferred back to the College.

ITALIAN.

Italian is given principally as a substitute for other languages, or as a one year elective. Its utility would principally depend upon the needs a student would anticipate meeting in practice.

LATIN.

Of the twenty-one indicating Latin, 13 prefer it taken in High School. If not taken in High School, it is mostly indi- be transferred back to the College?

MATHEMATICS.

Mathematics varies from a highly desirable elective where one states that a student should have as much as possible, to a doubtful subject. Most think it should be pursued through Trigonometry and Algebra, or about one year's work. Others think half a year is sufficient. One definitely does not desire it beyond the entrance requirement. In this connection, review the remarks on Chemistry as a pre-medical subject. One Dean believes that two years of mathematics is very wise, when its values are considered from a number of different standpoints.

PHILOSOPHY.

A large number are in favor of Philosophy in the premedical curriculum than those who are opposed to it. One believes 2 years of study is excellent, but the average period of study is 3-6 hrs. through one year.

PHYSICS.

Three desire 10 semester hrs. in Physics, most indicate 8 hrs. At Yale it is optional with Physical Chemistry. There is considerable dissatisfaction with the teaching of Physics to premedical students. Detroit advocates a special course for them, as certain English Colleges actually do present. It is stated that to the premedical student the average problems in Dynamics, etc., are comparatively valueless whereas the principles of Hydrostatics, Hydraulics, Pressure of Gases, conductivity, etc., are more important. It is remarked with truth that to the Physics teacher the average premedical student is a nuisance, if any special effort is made to provide for his needs. Another Dean states his belief that the study of Physics is over emphasized for the practitioner in medicine, as it belongs more to the specialist side. In this connection the remarks made in the discussion of English as a premedical requirement are of interest.

POLITICAL SCIENCE.

Those who wish this subject in the premedical course indicate 1-4 semester hrs. and one year as the time to be devoted. It undoubtedly is a liberalizing element.

PSYCHOLOGY.

Psychology is classified by nearly all as a very desirable elective. The time to be consumed varies from 2 sem. hrs. to 2 years work. Most prefer a 3 hr. course. Two believe that it should be substituted in part at least for the time devoted to a foreign language. One thinks that the instruction should be in the medical curriculum, but as we shall later see there is no place for it. Another reminds of its necessity as a basis for the study of insanity.

SOCIOLOGY.

The remarks made for Psychology will apply to Sociology also. One Dean regards it as being more important than economics for the study of medicine.

MISCELLANEOUS.

STATISTICS is not universally desired, but where indicated varies from 2 sem. hrs. to one year. SPANISH is regarded by some as a desirable elective, while FREEHAND DRAWING is classified as being very useful. Three added LOGIC to the questionnaire. This subject was suggested rather than a strongly urged elective in the 1922 edition of *"Choice of a Medical School,"* which was in the hands of the Deans at the time the questionnaire reached them, this possibly accounting for the small number indicating it.

The ideals guiding the choice of the subjects previously named are summed up in a letter from one Medical School—"the student should get a good foundation in fundamentals. We believe in a broad and cultural college course, as well as a good preliminary scientific training," Some, however, maintain that the premedical course should be as broad in the humanities as in the sciences, but feel that economic conditions argue against an increase in the requirements for the degree of Doctor of Medicine. We shall later see that the expansion of medical science will imperatively demand appropriate readjustment, and if the medical curriculum is not to be lengthened, some of the present day medical school work must be shifted back to the Colleges of Arts and Sciences. So far then as is possible, the premedical work of the future physician should transform him into an educated man, (actually stated), before he takes up medicine, but in the words of one Dean, "if liberalizing courses are advocated by some, we must not forget that a distinguished educator said that every study is liberal if pursued in a liberal spirit," a point of interest to those who are opposed to greater preparation in Biological science.

It is now clear that there is dissatisfaction on the part of some Class A Medical Schools with the prevailing requirements and indicated content of pre-medical education. Such concerns the actual subjects studied and the range of utility they should be to the student. Schools which are conservative concerning the indicated requirements, definitely state, however, that the Colleges would better prepare students for med-

icine if they introduced higher standards of admission and accomplishment, when the students under existing requirements would be well enough fitted for progress in Medical School. Three Deans write that they do not believe 30 sem. hrs. work is sufficient for a student to complete in a year, consequently beginning medical students do not react suitably to the far heavier program in Medical School, because they are not used to it. It is believed that the better Colleges and Universities know that their students are not overburdened with work, but all seem to have difficulty in evolving suitable plans to tighten up their standards as a step toward giving their students more to do.

It is to be regretted that all the Deans did not reply to the questionnaire, even after a second request was made for it, and that others did not furnish the information in such detail as would make these results more complete. To all who contribute in connection, including Mr. H. J. Bush, a former assistant of mine whose aid was especially valuable, my hearty thanks are due.

Reflection leads to the conclusion that the minimum entrance requirements to acceptable Medical Schools as already stated, have been established with regard to the following reasons:

1. To provide the minimum fundamental background for the study of medicine, which a student should also master as a test of his ability to commence his strictly professional studies.

2. To formulate the requirements for such a background with regard to the economic circumstances of the average student and those surrounding his future practice of medicine. Some for example, consider it desirable to enter practice as soon as possible, but at a period considered early by others.

3. It is possible that with regard to one subject and its divisions, e. g. Biology, that the entrance requirements are at present adapted to the caliber of instruction that most Colleges are felt able to give, for while the medical curriculum is badly crowded, certain Biological subjects such as Histology, Bacteriology etc., which are given in many Colleges, are re-

tained in the medical curriculum, where it is true they are given more thoroughly. At the same time these are often taught by men who have taken their Doctor's degree in Biology, although some have completed a medical course subsequently with the idea of better understanding the medical aspects of the science. In short the difference between the Biology of the Colleges and that of the first two years of the Medical Schools is largely a question of the amount of work covered as safeguarded by standards, points to which Colleges are now reacting.

If in connection with the preceding we consider the strongly urged and suggested electives laid down by the American Medical Association, the returns of the questionnaire and the opinions of the authorities as to the best and widest scope of premedical education, we are led to believe that a four year, required premedical course is one which will most satisfactorily meet the situation especially in view of other points to be brought out.

It is true that a required four year premedical course is concerned only with the first and third reasons given for the minimum entrance requirements stated above, for so long as but two years premedical work is required as a minimum by certain schools, many students will not take a longer period. The time element at present seems to be an important one to consider in educating physicians, as in certain regions, especially rural ones there is a dearth of them. It will always be difficult to encourage men to enter the profession, when in a similar period of preparation for other occupations, they have prospect for ultimately greater financial rewards. On the other hand the medical profession desires to conserve the high esteem it has always held in the human mind, and as a possible consequence, many medical schools are now requiring in addition a collegiate degree for entrance, as insuring the least acceptable background. This does not seem too much when one remembers that ability to complete a College course has been shown not to positively insure a student's success in medical school. It is fair then to assume that some advantage could accrue to the student if during the remaining years of his pre-

medical work, the subjects of his course would be definitely such as to combine additional cultural subjects as well as to give him the lay of the land ahead by means of instruction in advanced Biological subjects. Thorough instruction in the latter if survived by the student, would probably go a long way toward making an easier transition to medical school, for medicine is essentially applied Biology, and under existing conditions it would tend to lighten the burden of the first two years perhaps his hardest, but at the same time, closets to his premedical work. Additionally it would tend to give him more time for personal growth, such as assisting in research, or for that matter any pursuit enabling him to find the field of medicine for which he is best fitted. This fits in with the old fashioned but most satisfactory idea, that a physician should be a leader in his community.

As an example of the present day attitude of medical schools in this matter, it will be remembered that certain medical schools do not wish the student to have had previous instruction in collegiate Histology or Embryology, claiming at least that such robs their teaching of its novelty. However, others state that they have scarcely time to give the important things in these subjects under existing conditions of instruction, while some recognize the usefulness of cultural preparation of Biological subjects in studies such as Human Anatomy, which is at best largely a matter of mechanical memory for the student—hence their suggestion that the student take Comparative Anatomy as an elective, a subject which has both practical and cultural values for Anatomy and Embryology of the Medical School. Still other institutions recognized the principles involved in the last statement, and specify that if Embryology and Histology be taken, the former be non-mammalian while the latter should be a general animal Histology, neglecting the human aspect.

If we have been led to believe that premedical education should at least cover a period of 3-4 years; that the present day medical curriculum is overcrowded with prospects for greater overcrowding still as medical science explores new fields; if we desire to shorten with a desirable consistence of cultural

and practical aims the period of study of the premedical student before he commences to earn his livelihood, it seems probable that the Medical Schools, if only for the reason they will require further time for their purely medical subjects, must either increase their period of instruction, (already lengthened by some to include a fifth interne year), or return some of it to the pure science of the Colleges and Universities. Somewhat of a tendency toward this is seen in the 7 year combined premedical and medical courses of certain universities where the senior year for College credit is taken in the Medical School. Although the time factor of the student was probably the primal reason for this combination, disadvantages appear in this plan when it is regarded from the cultural side, for while students may profitably take their advanced Biological science in this way, yet a good deal of time is lost from the cultural subjects which might eventually enable the future physician to find his better field of service.

Dartmouth College,
Hanover, N. H.

BOOK REVIEWS

In this section are reviews of new, or particularly important and interesting books in the fields of natural science. Books dealing with botany or kindred subjects should be sent to the Editor, the University of Notre Dame. *All other books for review* should be sent to Carroll Lane Fenton, at the Walker Museum, the University of Chicago, Ill. Publishers are requested to furnish prices with books.

THE HUMANIZING OF KNOWLEDGE. By James Harvey Robinson. George H. Doran Co., $1.50. (paper bound, $1.00.)

There are plenty of complaints, on the part of scienists even, that most knowledge is so bound up in technicality as to be useless to nine tenths of educated humanity. So far as I am aware, however, Professor Robinson is the first specialist to take these plaints seriously to heart and try to do something for the general remedying of the matter. This book contains his plan of action and his basis for it; both of them look extremely solid.

In the first essay Dr. Robinson admits man's general indifference to knowledge, and shows that the seeker after truth is not only an exceptional being, but often a positive freak. In the second, he shows that for science to be of any value at all, it must be dehumanized to some extent at least. By "dehumanized" he does not mean 'dry,' but rather 'unemotional' or 'unprejudiced.' The dryness is an incidental and unnecessary feature. Other essays cover such subjects as the importance of scientific discoveries, the present organized opposition to facts of all sorts that do not fit in with inherited ideas, and finally, a proposal for writing of a sort that will combine both accuracy and interest. Dr. Robinson is not interested in "popular science" of the sort that fills pages of the Hearst dailies; what he wants is the real thing, at once readable and reliable. The essay on "The Democratization of Science" outlines the subjects and attributes of a whole series of books that would fill his requirements. The publishers say that they have started to work on the plan; a most promising assurance, but I confess myself alarmed by a "group of the ablest scientists in the United States and abroad." Dr. Robinson may convert publishers to popularize science, but can he convert scientists to the use of plain English? I wonder.

—C. L. F.

THE FERN LOVER'S COMPANION. By George Henry Tilton. Little, Brown & Co. $3.00.

Every lover of nature feels the fascination of ferns even though he may know little of their names and habits. He finds them in little valleys, on rugged cliffs, bordering pretty streams, and carpeting old sand dunes. If he knows them already, he is incited to new interest and study;

if he is not, he wishes some book that will help him to a prompt and close acquaintance. Such a volume is this by Mr. Tilton.

With the purpose of the book stated, we may proceed to its contents. First is an introduction, giving the general facts of reproduction, structure and habit. Then a key to the genera which, though brief seems quite edaquate. At least, I, who am the merest tyro in botany, have used it and found my determinations approved by the expert to whom I took them. In a few cases I went on to use the third part, which discusses the numerous species of ferns, and there too I was successful. And this indeed is a recommendation. If one who knows so little of ferns as I can achieve accuracy by the use of Mr. Tilden's book, what might the initiate do?

I cannot pass the volume by without comment on the illustrations, which are numerous and excellent. It is no exaggeration to say that they account for half the book's usefulness, and will form a valuable supplement to even far more exhaustive treatises. Pictures do not make a diagnosis, but they do make that diagnosis usable to about ninety-nine percent of the people. The ones in this book come close to the high-mark of excellence. In fine, "The Fern Lover's Companion" is an attractive thing, different from all other books on ferns that I have seen, and wholly fine.

—C. L. F.

THE BOY'S OWN BOOK OF SCIENCE. By Floyd L. Darrow. The Macmillan Co.

EVERYDAY MYSTERIES. By Charles Greedy Abbot. The Macmillan Co.

DWELLERS OF THE SEA AND SHORE. By William Crowder. The Macmillan Co.

Here are three books, each of them excellent, each of them interesting, and each of them thoroughly reliable. In the first, Mr. Darrow appeals specially to the boy or girl who likes to work with test-tubes and chemicals, giving over a hundred significant experiments which can be carried on either at home or in any high-school laboratory. There are many pictures of youngsters actually at work, and plenty of diagrams showing how to manipulate the necessary apparatus. The interest of several experiments is heightened by short sketches of the scientists who originally made them—an excellent means of making science real.

Mr. Abbot, writing for younger people than Mr. Crowder, makes a less direct appeal to these with well-developed hobbies. His subjects are the ordinary things of a household—doorbells, furnaces, and sweepers, as well as the more striking of natural objects, such as the sun, the sea, and garden plants. On the whole he makes the things which he discusses very attractive; so much so that his book should appeal not only to his special audience of children, but to high school students, parents, and even teachers as well. The grade teacher, equipped with the knowl-

edge that Mr. Abbot makes easily accessible, could answer readily many of the questions which her pupils are bound to ask, and could answer them convincingly. And for that matter, there are many college graduates (not excepting the present reviewer) who can learn much from "Everyday Mysteries."

But the best book of the three, by all odds, is Mr. Crowder's "Dwellers of the Sea and Shore." Ostensibly it is designed for youngsters aged 12 to 15; as a matter of fact, it is suited to the needs of anyone from 12 onward, providing he has a liking for living animals. It lacks both the technical words which often make a book suitable for study but not for reading; at the same time it is burdened with none of the childish Burgess-esque baby-talk which makes many a nature book fit only for the rubbish heap.

To review the book fully would be to write a summary of marine natural history. Instead, I shall outline its organization, and mention a few specially attractive chapters, in the hope of both indicating the general nature of the contents and showing the unusual features of the book. Part one is entitled "The Seashore," and includes such chapters as "The Seashore Naturalist," "Social Life in the Salt-water World," "Marine Groves and Gardens," and "Feathers and Feelers." In them appear such old friends as the starfish, sea urchin and hermit crab, as well as the less known moon snail, comb jellies, and salt-water plants. Part two, dealing with the life of tide pools, includes more unusual animals—squids, worms of several types, and unusual sorts of crabs. The most interesting single chapter is entitled "A Living Fossil," and recounts the life habits of the horse-shoe crab, relative of the ancient trilobites. Oddly enough, though specimens of the creature are to be seen in museum and curio store, this is the one complete and readable account of his ways of living that is to be found in an accessible English book.

The third and last section, entitled "The Open Sea," describes those creatures which the technical zoologist labels "pelagic." From protozoa and corals to fishes and whales the account runs, combining interest with accuracy in a manner that leaves little to be desired. The last chapters, on "Life in the Ancient Seas" and "Our Salt-water World," give summaries of our knowledge of fossil marine animals and our knowledge of the sea itself. Necessarily these summaries are brief; each of the subjects would justify a book the size of the one which Mr. Crowder has written. But they are not hasty, and therein lies their excellence. If one wishes to go farther into the fields they afford an excellent base for reading; if he wishes to stop where he is, they give him a well proportioned general view. And they are not dry.

—C. L. F.

The American Midland Naturalist

PUBLISHED BI-MONTHLY BY THE UNIVERSITY OF NOTRE DAME, NOTRE DAME, INDIANA

VOL. IX. MAY, 1924. NO. 3

Distributional Features of Naiades in Tributaries of Lake Erie.

DR. A. E. ORTMANN.

The Naiad-fauna of Lake Erie is a glacial-postglacial offshoot of the Mississippi-Ohio-fauna, which has come chiefly by way of the Wabash-Maumee-route. This has been pointed out repeatedly (Ortmann, '12 p. 146; Walker, '13 p. 18, 58.) Some of the species are fully identical, but in other cases, Lake Erie proper contains more or less different forms, which, however, clearly take the place of the Ohio-types.

But one striking additional fact has been observed. The species of the Ohio, represented in the lake by different forms, generally present, in the tributaries of the lake, the common Ohio-phase, although this is not always the case. This fact has been commented upon by Walker ('13 p. 19), but he used it only in connection with the demonstration, that there are no pre-glacial relics in the lake basin. The present writer ('19) has pointed out several such cases*, and also Grier ('19 p. 163, 164) incidentally mentions this fact, although he does not take up this question in detail.

Several explanations have been suggested. (1) The one, that the types of shells of the lake tributaries identical with Ohio-types, are pre-glacial, has been finally disposed of by Walker. (2) Another suggestion is, that these forms, chiefly those of the southern tributaries of the lake, might have crossed over the divide from the tributaries of the upper Ohio (by stream-piracy or modern canals.) This has been hinted at by myself, ('19 p. 103),

* *Fusconaia flava*, p. 25; *Amblema costata*, p. 33; *Elliptio dilatatus*, p. 103; *Lasmigona costata*, p. 132; *Ligumia recta latissima*, p. 279; *Lampsilis siliquoidea*, p. 291; *Lampsilis ovata ventricosa*, p. 306.

but I was unable to find positive evidence for it. As will be shown below, this possibility *is positively excluded in certain cases, and surely does not apply in the case of northern and western tributaries of the lake.* (3) A third assumption is, that these forms, having reached the lake by the Maumee route, and having changed in the lake, ascended then from the lake into the tributaries, and assumed again the identical characters which they had, when living in the upper Ohio. This idea has been indicated by myself ('19 p. 25, 33, 132), but it is hard to imagine, that in every tributary, into which one of these lake forms went, it always returned precisely to the ancestral Ohio form. Below we shall become acquainted with at least two cases, where *this assumption is positively excluded,* because the forms concerned are not at all found in the lake.

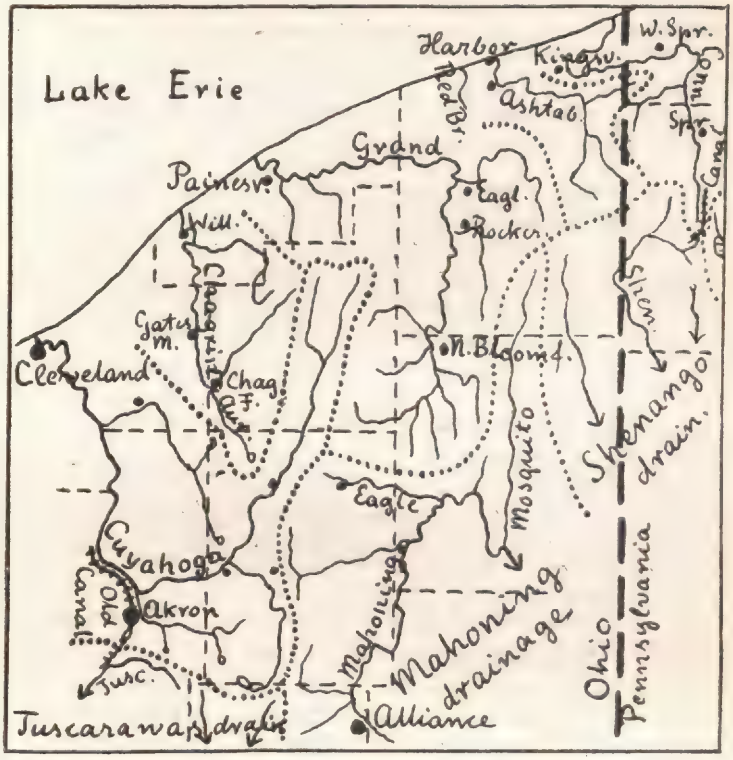
Thus there are objections to the assumption that any one of the above explanations is to be regarded as a *general* distributional law, and we are to look for another theory to which all of these cases might submit. And indeed, there is one, which has never been advanced. It is suggested by the *geological history* of the Lake Erie basin, and the present paper is written with the purpose to show, that there is another explanation, which *in several cases is the only possible one,* but which also can be applied very naturally to all other cases, although in some of them also the second idea, mentioned above, (crossing of the divide from the South) might be introduced as an additional possibility.

The new explanation entered my mind, when I explored certain tributaries of Lake Erie in northeastern Ohio and northwestern Pennsylvania, the basins of Chagrin River, Grand River, and Conneaut Creek (no Naiades were found in Ashtabula River.) Chiefly Grand River proved to be interesting for several reasons: it possesses a rather rich fauna; was never connected with the upper Ohio drainage by a canal; and, finally, it was found, that several Naiades present in this river could not have found their way into it by having been transferred from the upper Ohio drainage by stream piracy, simply because they are not present in this part of the Ohio drainage.

In order to present all the facts at my disposal, I first give

a list of my own (and previous) distributional records. (See: map fig. 1.)

Fig. 1.



TRIBUTARIES OF LAKE ERIE IN N. E. OHIO.

CHAGRIN RIVER. (Lower part polluted by paper mill at Chagrin Falls.)

1. Ch. R., Willoughby, Lake Co., O. (Sept. 10, '20.)
   Lampsilis siliquoidea (*Barn.*) *Lampsilis ovata ventricosa* (*Barn.*)
2. Ch. R., Cuyahoga Co., O. (Hartman coll.)
   Lampsilis ovata ventricosa (*Barn.*)
3. Ch. R., Gates Mill, Cuyahoga Co., O. (seen, Sept. 9, '20.)
   Lasmigona costata (*Raf.*) *Lampsilis ovata ventricosa* (*Barn.*)
4. Ch. R., below Chagrin Falls, Cuyahoga Co., O. (seen, Sept. 8, '20.)
   Lampsilis siliquoidea (*Barn.*)
5. Ch. R., Russell Twp., Geauga Co., O. (above falls) (Sept. 8, '20.)

Lasmigona compressa (*Lea*) *Anodontoides ferussacianus* (*Lea.*)
Lasmigona costata (*Raf.*) *Strophitus rugosus* (*Swains.*)
Anodonta grandis Say

6. Aurora Branch, Chagrin Falls, Cuyahoga Co., O. (Sept. 8, '20.)
Lasmigona compressa (*Lea*)

GRAND RIVER. (Everywhere in good condition, without any pollution.)

1. Painesville, Lake Co., O. (Sept. 11, '20.)

Fusconaia flava (*Raf.*) *Ptychobranchus fasciolare* (*Raf.*)
Amblema costata Raf. *Obovaria subrotunda lens* (*Lea*)
Pleurobema cordatum coccineum (*Conr.*) *Actinonaias carinata* (*Barn.*)
Proptera alata (*Say*)
Elliptio dilatatus (*Raf.*) *Micromya iris novi-eboraci* (*Lea*)
Lasmigona costata (*Raf.*) *Ligumia recta latissima* (*Raf.*)
Alasmidonta marginata (*Say*) *Lampsilis siliquoidea* (*Barn.*)
Strophitus rugosus (*Swains.*) *Lampsilis ovata ventricosa* (*Barn.*)

Of these, *Strophitus rugosus* and *Lampsilis ovata ventricosa* have been mentioned before from the same place by Simpson (in: Kirsch, '95.) The Carnegie Museum possesses *Actinonaias carinata* also from the Sterki collection.

2. Eaglesville, Ashtabula Co., O. (Sept. 16, '19.)

Fusconaia flava (*Raf.*) *Anodonta grandis Say*
Amblema costata Raf. *Ptychobranchus fasciolare* (*Raf.*)
Pleurobema cordatum coccineum (*Conr.*) (seen) *Obovaria subrotunda lens* (*Lea*)
Micromya iris novi-eboraci (*Lea*)
Elliptio dilatatus (*Raf.*) *Ligumia recta latissima* (*Raf.*)
Elliptio complanatus (*Dillw.*) *Lampsilis siliquoidea* (*Barn.*)
Lasmigona costata (*Raf.*) *Lampsilis ovata ventricosa* (*Barn.*)

3. Rockcreek, Ashtabula Co., O. (Sept. 8, '19.)

Fusconaia flava (*Raf.*) *Obovaria subrotunda lens* (*Lea*)
Amblema costata Raf. *Actinonaias carinata* (*Barn.*)
Elliptio dilatatus (*Raf.*) *Micromya iris novi-eboraci* (*Lea*)
Lasmigona costata (*Raf.*) *Ligumia recta latissima* (*Raf.*)
Anodonta grandis Say *Lampsilis siliquoidea* (*Barn.*)
Ptychobranchus fasciolare (*Raf.*) *Lampsilis ovata ventricosa* (*Barn.*)

4. North Bloomfield, Trumbull Co., O. (Sept. 17, '19.)

Fusconaia flava (*Raf.*) *Lasmigona costata* (*Raf.*)
Amblema costata Raf. *Obovaria subrotunda lens* (*Lea*)
Pleurobema cordatum coccineum (*Conr.*) *Micromya iris novi-eboraci* (*Lea*)
Lampsilis siliquoidea (*Barn.*)
Elliptio dilatatus (*Raf.*) *Lampsilis ovata ventricosa* (*Barn.*)

In addition, Call ('85 p. 9) gives *Anodontoides ferussacianus buchanensis* (*Lea*) from Grand River, and Sterki ('07 p. 394) mentioned this under the varietal name of *subcylindracea* (*Lea*). This form is hardly different from the normal *A. ferussacianus.*

RED BROOK, 3 m West of Harbor, Ashtabula Co., O. (Sept. 13, '20.)
(A very small stream; shells found dead within a mile from the lake.)

Lasmigona compressa (*Lea*) *Anodontoides ferussacianus* (*Lea*)

CONNEAUT CREEK (in good condition for its whole length.)

1. Kingsville, Ashtabula Co., O. (Sept 12, '20.)

Pleurobema cordatum coccineum (*Conr.*)
Lasmigona compressa (*Lea*)
Lasmigona costata (*Raf.*)
Anodontoides ferussacianus (*Lea*)
Alasmidonta marginata (*Say*)
Strophitus rugosus (*Swains.*)
Ptychobranchus fasciolare (*Raf.*)
Micromya iris novi-eboraci (*Lea*)
Lampsilis siliquoidea (*Barn.*)
Lampsilis ovata ventricosa (*Barn.*)

2. West Springfield, Erie Co., Pa. (May 23, '09) (published in '19.)

Pleurobema cordatum coccineum (*Conr.*)
Elliptio dilatatus (*Raf.*)
Lasmigona compressa (*Lea*)
Anodonta grandis Say
Anodontoides ferussacianus (*Lea*)
Alasmidonta marginata (*Say*)
Strophitus rugosus (*Swains.*)
Ptychobranchus fasciolare (*Raf.*)
Micromya iris novi-eboraci (*Lea*)
Lampsilis siliquoidea (*Barn.*)
Lampsilis ovata ventricosa (*Barn.*)

3. Springboro, Crawford Co., Pa. (June 4, '08) (published in '19.)

Pleurobema cordatum coccineum (*Conr.*)
Strophitus rugosus (*Swains.*)
Lampsilis siliquoidea (*Barn.*)
Lampsilis ovata ventricosa (*Barn.*)

The Naiad-fauna of these streams consist of 19 species, and is rather uniform, with the qualification, that the largest (Grand River) contains more species than any of the others. Grand River has 6 species not found in the others (*Fusconaia flava, Amblema costata, Elliptio complanatus, Obovaria subrotunda lens, Actinonaias carinata, Proptera alata.*) Two species found in other streams (*Lasmigona compressa* and *Anodontoides ferussacianus*) have not been found recently in the Grand (the latter, however, has been reported by Call), but they apparently have been missed by myself only by accident. Since these two species are unimportant for our present purpose, we may safely take the *Grand River fauna as typical for this region,* and restrict our further discussion chiefly to this river.

Of the shells found here the following are found in the upper Ohio drainage, but differ more or less from the lake-form; in most cases, different names are in use, as indicated below (see: Grier, '18, Ortman, '19, Grier, '19.)

In Grand and Ohio	In the lake
1. *Fusconaia flava* (*Raf.*)	*Fusconaia flava parvula Grier*
2. *Amblema costata Raf.*	*Amblema plicata* (*Say*)
3. *Pleurobema cordatum coccineum* (*Conr.*)	*Pleurobema cordatum pauperculum* (*Simp.*)
4. *Elliptio dilatatus* (*Raf.*)	*Elliptio dilatatus sterkii Grier*
5. *Lasmigona costata* (*Raf.*)	*Lasmigona costata eriganensis Grier*
6. *Strophitus rugosus* (*Swains.*)	*A dwarf form* (Ortmann, '19 p. 200)
7. *Ptychobranchus fasciolare* (*Raf.*)	*A dwarf, humped form* (Ortmann, '19 p. 210)
8. *Obovaria subrotunda lens* (*Lea*)	*Obovaria subrotunda leibi* (*Lea*)
9. *Proptera alata* (*Say*)	*A smaller, more swollen form* (Ortmann, '19 p. 254 and Grier, '19 p. 165)
10. *Ligumia recta latissima* (*Raf.*)	*Ligumia recta* (*Lam.*)
11. *Lampsilis siliquoidea* (*Barn.*)	*Lampsilis siliqoidea rosacea* (*DeKay*)
12. *Lampsilis ovata ventricosa* (*Barn.*)	*Lampsilis ovata canadensis* (*Lea*)

Thus it is seen, that in over half of the cases (12 out of 19) the fact is established, which has been indicated in the beginning: *that the Naiades of the Lake Erie tributaries resemble those of the Ohio drainage more closely than those of the lake itself.*

The other species of Grand River have the following distribution and affinities.

13. *Alasmidonta marginata* (*Say*) 14. *Actinonaias carinata* (*Barn.*)

Both are species found in the identical form in the upper Ohio drainage, and are present in other tributaries of the lake; but in the lake itself they are absolutely missing. For our further studies, these two species will be very important.

15. *Micromya iris novi-eboraci* (*Lea*) (see: Ortmann, '19 p. 270.)

This species stands by itself. It is characteristic for the lake-drainage from New York to Michigan, both in Lake Erie and its tributaries, but it is not found in the upper Ohio drainage, where its place is taken by the typical *Micromya iris* (*Lea*). We have here a case of an identical form in the lake and its tributaries, but different from the Ohio-form.

16. *Lasmigona compressa* (*Lea*)

This is found in the upper Ohio drainage, in tributaries of the lake, and in the lake proper. Its value for distributional

studies is thus doubtful. But the fact that it is extremely rare in the lake (only 2 specimens ever recorded, one from Presque Isle, Pa., the other from Sandusky Bay, O.,) approaches this species to those which are not in the lake (Nos. 13 and 14 above.) It has the appearance, as if this species abundant and flourishing in tributaries and small streams in general, does not take kindly to the lake-environment.

17. *Elliptio complanatus* (*Dillw.*)

This is an abnormal case. It is an Atlantic species, not found in the upper Ohio and not elsewhere in the Erie drainage. I shall discuss this case at the end.

18. *Anodonta grandis Say* 19. *Anodontoides ferussacianus* (*Lea*)

These will be left out of consideration. Although in both the lake-form is somewhat different from that of the tributaries, and although the latter again generally resembles the Ohio-form, the various forms are not strictly separated along these lines. *Anodonta grandis footiana* (Lea), the lake-form, has been frequently reported from the Ohio-drainage, and in *Anodontoides* the same condition apparently prevails; but in this case the forms require further investigation, the var. *buchanensis Lea,* generally attributed to the lake, probably having been misunderstood.

THE THEORY OF THE CROSSING OVER THE DIVIDE.

(See: map fig.1)

There has never been a canal connecting the headwaters of Grand River with the Ohio system. This is true also of Chagrin River, but is different in the case of Conneaut Creek, where the headwaters come into contact with those of the upper Beaver (Shenango) River and French Creek (tributaries to Ohio, respective Allegheny.) This region was traversed by the old Beaver Canal, and I have suggested ('19) the possibility, that Conneaut Creek might have received some of its shells by this route (from Shenango River in Pennsylvania.) But since the species, which might have taken this route (*Pleurobema cordatum coccineum, Elliptio dilatatus, Lasmigona costata, Alasmidonta marginata, Strophitus rugosus, Ptychobranchus fasciolare, Lampsilis siliquoidea, Lampsilis ovata ven-*

tricosa) are not peculiar to this system, and possess all a rather general distribution, being also found in Grand River, where there was no canal, *this way of migration is for Grand River excluded,* although it should be admitted as a possibility for Conneaut Creek.

The canal-theory deserves more consideration in the case of Cuyahoga River, the next tributary of the lake to the West of Chagrin River. This was connected by a canal with the Tuscarawas-Muskingum system of the Ohio. In Cuyahoga River there is at least one species of the Tuscarawas drainage, *Lasmigona complanata* (*Barn.*), which is not found in the lake, and just this species favors the canal-environment.*

The headwaters of Grand River closely interlock with that of the Beaver drainage, in fact, they are almost surrounded by it (Mosquito and Eagle Creeks, tributaries to Mahoning River), with the exception of the western side, where they come into contact with the headwaters of Cuyahoga River.

The upper Cuyahoga has a history of its own, and probably a rather complex one. It might once have belonged to the Tuscarawas drainage (Newberry, '73 pp. 204, 205); but the heavy, stratified gravels between the bend of the Cuyahoga and the Tuscarawas (near Akron) are considered glacial outwash by others (Leverett, '02, passim, and map. pl. 15.) There also might have existed here a large glacial lake, connected at different times toward the South and toward the North. For this reason it seems well to consider also this river in the following studies.

The Naiad-fauna of these rivers (Cuyahoga, Tuscarawas, and Mahoning) is well known† and of the shells mentioned above, the following distributional facts should be emphasized.

1. *Fusconaia flava.*—Missing in the whole Beaver (Shenango and Mahoning) drainage (Ortmann, '19 p. 17), but present in the uppermost Tuscarawas, near Akron; not in the upper Cuyahoga.

---

*The Cuyahoga fauna has other peculiarities, which deserve special discussion, but I cannot go into detail here. Some of the facts will be alluded to below.

†See: Dean, '90, Sterki, '07, and my own collections, partially published in '19.

2. *Actinonaias carinata.*—Missing in the upper Mahoning (Ohio part of it), and in the Shenango above Sharon, Pa. (Dean, '90, Ortmann, '19 p. 236); present in the Tuscarawas, but not in the headwaters above New Philadelphia (Sterki collection in Carnegie Museum); not in upper Cuyahoga.

3. *Proptera alata.*—Missing in the whole Beaver drainage (Ortmann, '19 p. 256), missing in the Tuscarawas (Sterki, '07 p. 393), and missing in upper Cuyahoga.

4. *Ligumia recta latissima.*—Missing in the Beaver drainage (Ortmann, '19 p. 280); present in Tuscarawas, but not in the upper part (above New Philadelphia) (Sterki collection); not in upper Cuyahoga.

Thus these 4 species are not found in that part of the Ohio-drainage which comes into contact with Grand River, and they are also absent in the upper Cuyahoga. For these, at least, the assumption of a crossing of the divide by stream-capture is positively excluded.

For the other species the following facts of distribution have been ascertained.

The following species are found in the upper Mahoning, upper Tuscarawas, but not in the upper Cuyahoga:

1. *Amblema costata*
2. *Pleurobema cordatum coccineum*
3. *Elliptio dilatatus*
4. *Lasmigona costata*
5. *Alasmidonta marginata*
6. *Ptychobranchus fasciolare*
7. *Obovaria subrotunda lens*
8. *Lampsilis ovata ventricosa*

Two more species are in all three systems:

Strophitus rugosus *Lampsilis siliquoidea*

The possibility must be granted that these last 10 species might have come into Grand River from the adjoining Ohio-tributaries, presumably by stream capture. However, in 8 of them, the upper Cuyahoga (if it ever was a tributary of the Tuscarawas) is excluded, and only in the last 2 species this latter river might come into question. But these two species are of such a general distribution, that they do not furnish any conclusive argument. The other 8 species, if they have

come from the South, could have come only from the Mahoning system.*

Although there are 8 cases, which would admit the theory that shells have been transferred from the upper Mahoning into Grand River by stream capture, there are 4 others, which are positively opposed to it. Moreover, there is no physiographical evidence for stream capture in this region. The divides are all ill-defined here, and, although a mingling of the waters is possible (and actually present at certain points), this concerns extremely small streams, into which no Naiades have advanced.

In order to support this conclusion, I may be permitted to introduce here the evidence furnished by the distribution of certain crayfishes (genus *Cambarus*). These creatures advance much farther toward the headwaters, than the Naiades, nevertheless their evidence is distinctly opposed to the theory that they have crossed the divide.

Grand River possesses the species *Cambarus propinquus Gir.*, characteristic for Lake Erie and many of its tributaries (also farther North and West), and this species is also in Ashtabula River and Chagrin River. The upper Mahoning River

---

*It might be interesting to say a few words about the upper Cuyahoga fauna. This consists of the following species (Dean, '90; Sterki and Ortmann collections in Carnegie Museum.)

Lasmigona compressa (*Lea*)	*Anodontoides ferussacianus* (*Lea*)
Lasmigona costata (*Raf.*)	*Strophitus rugosus* (*Swains.*)
Anodonta grandis Say	*Ligumia nasuta* (*Say*)
Anodonta imbecillis Say	*Lampsilis siliquoidea* (*Barn.*)

There is no evidence in this fauna for the former connection of the upper Cuyahoga with the Tuscarawas. The presence of *Anodonta imbecillis*, which is a form also found in the Tuscarawas, preferring lake and canal environment, cannot be introduced in favor of this assumption, for this species has a rather erratic range (also in Lake Erie basin.) *Ligumia nasuta*, a characteristic form of the lake, is a very peculiar type of shell in this region; it also is a typical lake-dweller. It is found nowhere else in northern Ohio in tributaries of the lake (except some very small and sluggish ones close to the lake in the vicinity of Toledo), and is also absent in the Maumee River. Possibly both species, *Anodonta imbecillis* and *Ligumia nasuta* are remnants of the fauna of a lake of good size (mentioned above), which once existed in this region, and was connected with Lake Erie by the lower Cuyahoga.

(as well as the whole Beaver drainage) has *Cambarus obscurus Hag.*, the form of the uppermost Ohio-drainage (including Allegheny and Monongahela.) In Conneaut Creek, both species are found, and here we may take it for granted, that the old Beaver-canal has acted.

From the Cuyahoga, the lake species (*C. propinquus*) has not been reported (but it is in Rocky River, a little to the West) : however, it may turn up here yet. In the upper parts of this drainage, in the Cuyahoga and its tributaries, as well as in several lakes, I found only *Cambarus propinquus sanborni* (*Fax.*), the form of the Tuscarawas and Muskingum Rivers: this surely indicates a closer connection of the upper Cuyahoga and the Tuscarawas, but it remains doubtful, whether this is due to old drainage-features, or to the modern canal.

This much is sure, that by the evidence furnished by both the Mussels and the Crayfishes of Grand River no stream piracy is probable in this region, and that there are cases which positively speak against it.

Of the four species of Naides, which could not have come from the Mahoning, none is found in Lake Erie. *Actinonaias carinata* is altogether missing there, and the three others (*Fusconaia flava, Proptera alata, Ligumia recta latissima*) are represented by more or less distinct forms. Yet all of these are present in other tributaries of the lake. Disregarding the Maumee (in which all four are present), but which is supposed to have been the route of immigration of all Ohio-types, we have them in the following rivers: Grand River in Ontario (all except *Ligumia*) ; lower Cuyahoga (all, but *Fusconaia* might have come from the Tuscarawas, which is excluded in the other three) ; Vermilion River (only *Proptera*) ; Sandusky River (all four) ; Raisin River, Mich. (*Fusconaia* and *Actinonaias*) ; Huron River, Mich. (*Actinonaias* and *Ligumia.*) In the cases of Grand River, Ont., Raisin and Huron Rivers, Mich, the argument also holds good, that these species could not have come from the Ohio drainage, since these systems do not come in contact with the latter.

This means that these four species, at present, have a *discontinuous distribution*, being found in a number of tribu-

taries of Lake Erie, but with the ranges separated by the body of the lake, and the same assumption, of course, is admissible, although not positively demonstrated, in all other cases here discussed. Thus a theory, which explains these four cases, also could be used in the others, although as an alternative it is not excluded, that they might have come across the divide from the upper Ohio at least in the state of Ohio.

Additional species which might fall under the same category with the above, and chiefly with *Actinonaias carinata*, are: *Alasmidonta marginata* (*Say*) and *Lampsilis fasciola Raf.* Both are not found in the lake. The former is in Grand R., Ont., in Raisin R., Mich., in Sandusky, Cuyahoga, Grand Rivers, O., and Conneaut Creek. The latter is known only from Raisin R., Mich., and Sundusky R., O. (both are in the Maumee.) Immigration into the tributaries of the lake in Ohio from the South is here also thinkable; but these species have the same *discontinuous* distribution in the lake tributaries, as the twelve mentioned above, and a theory explaining this discontinuity would also serve in their case.

It is clear, that such a theory should reconstruct a former connection of the now separated river-systems, a union of them into one system, to which they were tributaries.

THE NEW THEORY.

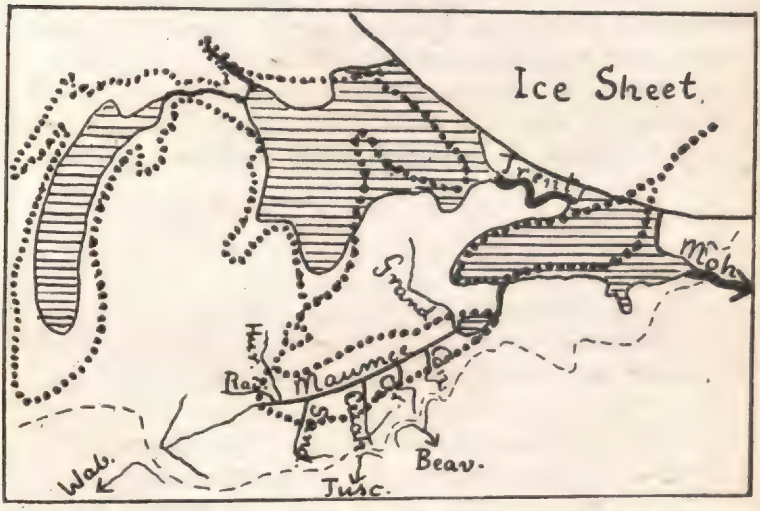
Turning to the glacial history of the lake, we find that indeed there was once such a drainage condition represented during the stages of the so called *Trent* and *Nipissing Outlets*, the former a little earlier, the latter a little later toward the end of the Glacial time. Both are characterized by the peculiarity, that the waters of the upper lakes (Superior, Michigan, Huron, at a certain time called Lake Algonquin) did not flow to Lake Erie (Detroit River route), but were flowing, in the Trent stage, from Georgian Bay of Lake Huron directly to Lake Ontario (Lake Iroquois), and, in the Nipissing stage, by way of Lake Nipissing to the lower St. Lawrence valley (at that time invaded by the Champlain Sea) (See map fig. 2)*

At this time, Lake Erie, at present a rather shallow body of

* See maps: Chamberlin & Salisbury, 3. '06 p. 401 fig. 521 and p. 404 fig. 522; also: Walker, '13 p. 44 fig. 4.

water, was practically dry, possibly only with a small remnant of a lake at its eastern end (near Buffalo), and, consequently, Maumee River, entering the basin at its western end, must have traversed it in the direction of its long axis, so that all the present tributaries of the lake (except possibly the most eastern ones) *must have been tributaries of this continuation of Maumee River.*

Fig. 2.



TRENT OUTLET STAGE OF GREAT LAKES.

Adapted from Walker, Naut. 27, 1913, p. 44 fig. 4.

Thus we obtain a system of connected rivers, an enlarged Maumee-system, collecting all the tributaries in which the Naiades here discussed are found, and this system had a continuous fauna, the Maumee fauna, which, as Walker has shown ('13) was mainly derived from the Wabash River, a tributary of the Ohio.

Later on, after the Trent and Nipissing Outlets were closed (the latter by a re-elevation of the continent in the North-East), the waters of the upper lakes were turned again, by way of Detroit River, into the Lake Erie basin, filling it up, and drowning the lower Maumee and the lower parts of its

tributaries. Only the upper parts of the latter persisted as rivers, becoming tributaries of the lake, and containing, up to the present time, the remnants of the once continuous fauna, now become *discontinuous*. In the new Lake Erie, the fauna, either died out (*Actinonaias carinata, Alasmidonta marginata, Lampsilis fasciola*), or (in most cases) changed under the influence of the different lake environment, producing those forms, which we know now as the representative lake-forms of the original river-types.

Of course, we should expect the old Maumee-fauna best preserved in the present Maumee (upper part of Maumee of Trent-stage), and this is actually the case: all the species discussed here (and many additional Ohio-types) are found in the Maumee.*) But this requires no special discussion, since this river formed the highway along which the Ohio-fauna migrated into the Erie basin.

For the other tributaries of Lake Erie, however, we are justified in drawing the following conclusion. The fact, that they contain a number of Ohio-types, which are represented in the lake by different forms, or not at all, must be explained, in the Grand River of Ohio and in the Grand River of Ontario, and also in tributaries at the western end of the lake in Michigan, by the assumption *that these rivers were at a certain time tributaries of an old Maumee River, continued along the Erie basin*, which was dry. This was towards the end of the Glacial Period, at the stages in the development of the Great Lakes known as the *Trent and Nipissing Outlet stages*. This continuous and connected river-system was rendered discontinuous by the re-filling of Lake Erie in Post-Champlain time. In the rivers named, this assumption is *imperative*, because an immigration from the Ohio-system (other than by the Wabash-Maumee route) is excluded.

Furthermore, if this is correct, nothing prevents the assumption that also in other tributaries the same explanation holds good. There is, indeed, the possibility, that in other

*A remarkable exception is *Ligumia nasuta*, which is not in the Maumee; this species stands by itself. It is of western origin, but apparently has a history of its own, being possibly one of the oldest immigrants into the lake-basin.

rivers in the state of Ohio some faunal elements of the upper Ohio drainage may have reached the lake-tributaries by stream-piracy in the region of the headwaters. But such forms cannot be singled out, since they do not differ from those which used the Maumee-route. In addition, some forms may have reached the lake-basin in very recent times, coming from the upper Ohio by canals, as in the cases of Conneaut Creek and Cuyahoga River, but such cases seem to be very few (one has been indicated above.) The Miami-Maumee and the Wabash-Maumee canals of recent times may also have helped to introduce additional Ohio-types into the lake-basin, and, indeed; there are several species known, where this might be suspected. But this is outside of the scope of the present paper, and, moreover, it concerns the same region covered by the old Wabash-Maumee route of immigration.

THE CASES OF MICROMYA IRIS NOVI-EBORACI AND ELLIPTIO COMPLANATUS.

Of the shells which compose the fauna of Grand River, two additional cases require further discussion.

Micromya iris novi-eboraci is found in the lake, in the Maumee, and a number of the lake-tributaries, but it is not in the upper Ohio-drainage, being represented there by *Micromya iris* (*Lea.*) The lake-form is not distinguishable from the form of the tributaries. In this case we may assume, that the form *novi-eboraci* came in recent times from the Maume into the lake, and then ascended into the tributaries. But, of course, there is no objection to the assumption, that it also is a remnant of the Trent-Nipissing stage, but that here the form has not changed in the lake. A few additional, similar cases are known: *Quadrula pustulosa prasina* (*Conr.*) (represented in the upper Ohio by *Quadrula pustulosa* (*Lea*); *Dysnomia sulcata delicata* (*Simp.*) (not in upper Ohio); and the following species which, although present in the Ohio-drainage, are not found in the tributaries in northeastern Ohio and northwestern Pennsylvania: *Quadrula quadrula* (*Raf.*), *Obliquaria reflexa Raf.*, *Truncilla truncata Raf.*, *Truncilla donaciformis* (*Lea*). For all these the same holds good as for *Micromya iris novi-eboraci.*

Finally, *Ellipto complanatus* (*Dillw.*) in Grand River is an anomalous case. This is a common Atlantic species, missing in the whole interior basin. Yet I have found a single individual, and Sterki ('07 p. 393) has reported a single shell from the Tuscarawas drainage near New Philadelphia, O., (collected in 1898; the specimen is now in the Carnegie Museum.)

This species is known from the St. Lawrence and Lake Ontario along the Nipissing and Trent routes to northern Lake Huron and the eastern part of Lake Superior (see map given by Walker, '13 p. 30 fig. 2), but does not go thence southward into the southern part of Lake Huron, and has never been found in Lake Erie.

Walker ('13 p. 45) connects this range with the *Trent Outlet stage*, and thinks that this species came from the Mohawk Outlet of Lake Iroquois (Ontario) up the Trent River into Lake Huron. This undoubtedly is correct, and it should be added that another species took the same route: *Lampsilis radiata* (*Gmel.*) (often called *borealis Gray.*) It is found practically in the same region, from New York state and the St. Lawrence to Lake Huron in the Georgian Bay region, but it does not go farther West.

The occasional presence of *Elliptio complanatus* in Grand River, and even in the Tuscarawas, is very astonishing. The only explanation I can think of, is the following.

Since there is, apparently, no natural barrier to the dispersal of this species from Lake Huron southward into Lake Erie, *Elliptio complanatus might be expanding its range in this direction at the present time*, not only into Lake Erie, but also into some of its tributaries, for instance Grand and Cuyahoga Rivers, and from the latter it might have reached the Tuscarawas by the canal. But only the forerunners, occasional individuals, are arriving. They might be also in the lake, but have not yet been discovered. It would be interesting to watch the further progress of this colonization. Of course we know that here, as generally among mussels, the dispersal probably is by transport in the larval stage by fishes,

but what we know about this shell in this respect does not furnish any additional information.*)

BIBLIOGRAPHY.

Call, R. E. Geographical Catalogue of the Unionidae of the Mississippi Valley (Bull. Des Moines Acad. Sci. 1. 1885 pp. 1-57.)

Chamberlin, T. C. & Salisbury, R. D. Geology. 3. Earth History, 1906.

Dean, G. W. Distribution of Unionidae in the Mahoning, Cuyahoga, and Tuscarawas Rivers (Nautilus 4. 1890. p. 21 ff.)

Grier, N. M. New Varieties of Naiades from Lake Erie (Nautilus 32. 1918 pp. 9-12.)

Grier, N. M. Morphological Features of certain Mussel-Shells found in Lake Erie, compared with those of the corresponding Species found in the Drainage of the upper Ohio (Ann. Carnegie Mus. 13. 1919 pp. 145-182.)

Leverett, F. Glacial Formations and Drainage Features of the Erie and Ohio Basins. (Mon. U. S. Geol. Surv. 41. 1902 pp. 1-802.)

Newberry, J. S. Report on the Geology of Summit Co. (Rep. Geol. Surv. Ohio 1. 1873 pp. 201-222.)

Ortmann, A. E. The Geological Origin of the Freshwater Fauna of Pennsylvania (Topogr. & Geol. Surv. Pa. (1910-1912) 1912 pp. 135-149.)

Ortmann, A. E. A Monograph of the Naiades of Pennsylvania. 3 (Mem. Carnegie Mus. 8. 1919 pp. 1-384.)

Simpson, C. T., in: *Kirsch, P. H.* Report on the Invertebrates of the Maumee River Basin (Bull. U. S. Fish Comm. (1894) 1895 p. 332.)

Sterki, V. A preliminary Catalogue of the Land and Freshwater Mollusca of Ohio (Proc. Ohio State Acad. Sci. 4. 1907 pp. 367-402.)

Walker, B. The Unione Fauna of the Great Lakes (Nautilus 27, 1913 pp. 18-23, 29-34, 40-47, 56-58.)

---

* The fish-host of this species is not positively known. Lefevre & Curtis (Bull. Bur. Fish. 30. '12 p. 168) have succeeded in *artificially* infecting the Yellow Perch (*Perca flavescens*) with the glochidia of ***Elliptio complanatus.***

Apios tuberosa Moench.

THEO. HOLM.

(With 14 figures drawn by the author.)

Considering the large number of perennial herbs represented by the *Papilionaceae*, it is remarkable to notice, how very few of these are equipped with rhizomes of any singular, characteristic structure. Pseudo-rhizomes are undoubtedly the prevailing type, with or without stolons; many of the species spread by means of such stolons, some few by rootshoots; only one, so far as we have observed, is capable of spreading by stolons as well as by root-shoots, namely *Lupinus perennis* L. The root-system shows also a very uniform structure, from a large tap-root to the ordinary filiform, profusely branched; the characteristic swollen storage-roots we know from *Galactia, Indigofera, Psoralea,* and *Pachyrhizus.* But rhizomes in the stricter sense of the word are very poorly exemplified. We have seen the peculiar, tuberous rhizome of *Lathyrus macrorhizus,* described by Warming, (1) which is formed by a section of the stem just above and below the cotyledons, besides that similar tuberous "nodi" may occur here and there, upon the subterranean shoots. Another type of tuberous rhizome and presumably one which is unique in this family, is the one known so well from the "Ground-Nut," *Apios tuberosa.* The rhizome of this plant shows a structure so peculiar, that it has been mistaken for a root. While Gray described it as "bearing edible tubers on underground shoots," Torrey called it "a root producing fleshy tubers, arranged at intervals like beads;" Taubert considered it to represent a root. But the anatomists, who examined the internal structure reached the correct conclusion, that the tuber is a part of a true rhizome. Nypels and Seignette have given a very detailed description of the internal structure, which shows several points of interest.

(1) For references consult the bibliography appended

From a comparative point of view very little is known, so far, about the structure of the aerial, vegetative organs, except that Trécul has described the secretory ducts. No other reference to the genus is given in Solereder's work on the anatomy of the Dicotyledons.

Apios being very frequent in swamps and moist thickets in our vicinity, we have studied a number of specimens during the last year, and the following notes are the result of our observations.

The external structure of the seedling and of the rhizome of the mature plant.

The seedling of *Apios,* (Fig 1) resembles that of most of the other members of the family with hypogeic cotyledons, and shows no indication of the singular structure of the subterranean stem of the older plant. The primary root (Fig. 1) is long and slender and ramified, but without tubercles. The epicotyl is erect, tall, and rooting at the base. The leaves are unifoliolate, the first two being almost opposite; they subtend axillary buds. The cotyledons remain enclosed within the seed, and the axillary buds evidently develop into subterranean shoots.

While the typical structure of the rhizome of the mature plant is moniliform, with rather numerous tuberous enlargements, some modifications occur. The ramification of the rhizome varies also to some extent; a monopodium is the most frequent type, however. But characteristic of the mature rhizome is the early withering of the foliage, the minute, membranaceous, scale-like leaves, thus it is not possible to determine with any certainty where the internodes begin or end. And as will be shown in the subsequent pages neither the tubers nor the slender stem-portions between these represent single internodes. A typical structure is shown in figure 2, where the small tubers are in their second year of growth, while in figure 3 they are just about to be formed.

Normally the aerial shoot, the vine, develops from the apex of the terminal tuber, the basal internodes of the vine may persist for a few years, and the buds in the axils of the small, scale-like leaves develop into aerial shoots. Subterranean shoots, at first resembling slender stolons (S in fig. 2), but

PLATE VII.

during the summer becoming tuberiferous, may develop close to the apex, at the middle, or at the base of the terminal tuber; or, less frequently, they may develop from any of the other tubers, which constitute the rhizome. But we have never observed a single case, where stolons were developed from the slender part of the rhizome. The slender portion together with the base of the tuber thus represents an internode, while the tuber itself is composed of at least two internodes, judging from the position of the stolons. The small, scale-like leaves of the stolons (Fig. 2) wither as soon as the tubers begin to be formed, and disappear completely. The roots are exclusively confined to the tubers; they are sparingly branched, and bear bacterial tubercles (Fig. 3.)

Extensive rhizome systems represent a growth of several years, depending on a single tuber, as the large one in figure 2, which shows three generations of aerial shoots and two of subterranean stolons, one slender, and one tuberiferous. In figure 3 only one very long stolon is developed, which is about to form tubers. These two figures (figs. 2 and 3) represent the rhizomes of two individuals, collected respectively in May (fig. 2), and in July (fig. 3.) The system of axes, aerial as well as subterranean, is developed in each case from a single tuber. In figure 2 the bases of two aerial shoots (St) are to be seen at the apex of the tuber. Two slender stolons (S) with small scale-like leaves, and with long internodes proceed from the same tuber, the one from near the apex, the other from near the middle. They grow in a horizontal direction, and having reached a certain length, cease growing. The terminal bud remains dormant until the succeeding spring, when it develops into an aerial shoot which is generally purely vegetative for several years. During the first summer, however, the stolons begin to increase in thickness at intervals, and this increase in thickness is accompanied by the development of several roots, while the slender parts of the stolons never produce roots. This stage is drawn in figure 3, the stolon showing increase in thickness at four different places. The apex of the stolon in this case has been injured, but as may be seen from the figure (fig. 3) a small, lateral branch has pushed out at the base of the terminal one. In figure 2, there is besides the

PLATE VIII.

two slender stolons a third one, which proceeds from the base of the large tuber, and has developed four very distinct tubers, of which the terminal is extended into an aerial shoot (St.), besides that it has also developed a small, lateral tuber, which is sessile—a very rare occurrence as it seems. This tuberiferous stolon thus corresponds with the very long stolon in figure 3, but it is one year older; and the difference in age between the stage of the slender stolons (figure 2) and the very long one just beginning to form tubers (figure 3) is only about three months.

At the apex of the tubers there is a terminal bud which may develop in either of two ways according to the position of the tuber. When the stolons are not prevented from continuing their growth horizontally beneath the surface of the soil the terminal bud as shown in figure 2 produces, or better, becomes extended into an aerial shoot. But, when the apex of the stolon is injured, as shown in figure 3, an axillary bud takes its place (figure 6) and continues the growth as a stolon for some time, or as an aerial shoot in the succeeding spring. As shown in figure 6 the apex of the young tuber bears a few scale-like leaves, two of which subtend axillary buds. These small leaves at the apex are not visible on the other tubers, nor is there any indication of similar leaves at the middle or at the base of the tubers in general. However, as has been mentioned above, the fact that stolons may develop at various parts of the tuber seems to indicate that some leaves must have been present, but having withered without leaving any scars. It does not seem probable that these lateral shoots upon the tuber owe their development to adventitious buds, since we observed them in similar relative positions in a number of specimens without any trace of subtending leaves.

The ramification of the tuber thus results in the development of a terminal, aerial shoot, the vine, and of several lateral shoots, all becoming subterranean stolons, which are monopodia, at least for some time. Moreover, the tuber persists in an active condition for several years, giving rise to new sets of stolons as shown in figure 2. It is characteristic of the roots that they are developed only upon the tubers. We never observed the development of roots from the slender parts of

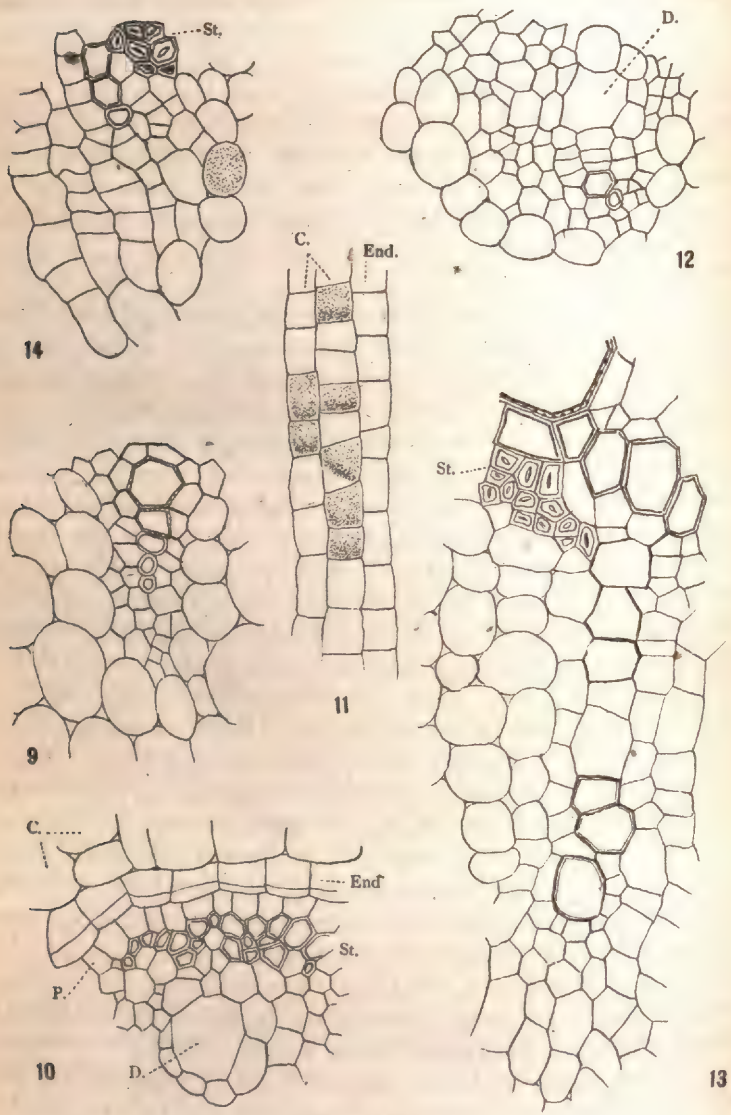


PLATE IX.

the rhizome. In rhizomes, in which the increase in thickening is less abrupt and less pronounced than in those figured, the root-system does not extend to the whole surface of the rhizome, but is restricted to certain portions scattered at intervals along the rhizome just as in the normal specimens.

Considered from a biological point of view *Apios* is well equipped for distribution by vegetative organs; its frequent occurrence, generally in abundance, is due to the development of tubers, rich in food-substances; thus capable of starting new individuals, when disconnected.

Internal structure of the vegetative organs.

THE ROOT-SYSTEM.

The secondary roots of a mature sepecimen (Fig. 8) show the following structure during the first season. Root-hairs are absent; the epidermis is thinwalled, and there is no hypoderm. The cortex is homogeneous, and consists of about ten compact strata with no deposits of starch, but several of the cells, especially close to the endodermis contain a solid, dark-brown or purplish substance, which is insoluble in alcohol. Balls of hyphae were observed in this parenchyma. The endodermis is thinwalled and destitute of starch. The pericambium, as usual, is a single stratum surrounding the stele. The stele is tetrarch with a wide vessel in the center, and the four rays are relatively short. The leptome represents a broad strand with a few stereids, of which the cell-walls are gelatinous, and a wide duct with distinct epithelium is located just inside the stereome; the duct contains a granular, colorless latex, and no tannin was observed in any parts of the root. No secondary increase was observed.

A corresponding structure recurs in the secondary and lateral roots of the seedling, but no stereids were observed in these. The primary root of the seedling, which is short-lived, lacks the stereome, but shows a slight increase in thickness within the stele only, there being eight mestome-strands and a relatively broad pith with deposits of starch. The brown or purplish substance, observed in the secondary root of the mature specimen, occurs also in the cortex of the primary root, but not in any of the other roots of the seedling.

THE AERIAL STEM.

The internodes are obtusely quadrangular (in cross-section) with a corresponding stele of about sixteen collateral mestome-strands and a broad, solid pith. The cuticle is smooth, thick, and the outer cell-wall of epidermis is thick. The stomata are sunk. The cortical parenchyma consists of four strata, of which the two peripheral are slightly collenchymatic; many of the cells, and frequently three or four together, contain a dark brown, solid substance, insoluble in alcohol. Inside the cortex is a thin-walled endodermis with the Casparyan spots plainly visible, but containing no deposits of starch. Inside the endodermis is an almost continuous sheath of stereome with gelatinous walls, in about five layers; it is interrupted here and there by short rays of thin-walled parenchyma extending from the interfascicular cambium. The mestome-strands represent a single band. The leptome forms large groups, and contains one or two wide ducts with epithelium, and filled with a clear, amorphic substance. The hadrome is also well represented with several porous vessels near the periphery, and some narrow spiral and annular vessels inside; several strata of slightly thickened libriform surround the vessels, forming an almost continuous band inside the cambium. The thin-walled pith is solid, and many of its cells contain the brown substance mentioned above. Viewed in longitudinal sections, the cells of the cortex containing this substance are often placed on top of each other as long, continuous rows, while those of the pith are much longer than the surrounding parenchyma, thus representing ducts, but with no epithelium.

The subterranean part of the same stem has a thin-walled epidermis, and the cortex is composed of about fifteen strata with numerous cells containing the brown substance, especially in those which border on the endodermis. Endodermis has become a phellogen, having developed several strata of thin-walled cork. The stereome is present as isolated, arch-shaped strands. The mestome contains more leptome and hadrome than in the aerial internodes, besides that the interfascicular cambium has given rise to secondary mestome-strands with

libriform, the walls of which are thick and gelatinous.

While the internodes of the seedling show the same structure as the aerial stems described above, the basal, swollen part of the epicotyl has a broader cortex of about eight strata with no deposits of starch, and with only a very few cells containing the dark-colored substance, moreover the stereome forms small, isolated strands, separated from the endodermis by a continuous layer of thin-walled parenchyma. There is also present a single stratum of endodermal cork.

The increase in thickness of the vine is thus confined to the basal, subterranean portion, and depends merely upon some few layers of endodermal cork, and the development of small, secondary mestome-strands from the interfascicular cambium.

THE RHIZOME.

The parts of the rhizome examined are: lateral stolons developed from large tubers viz. the very young, slender ones, marked S in figure 2; the long, creeping one in figure 3, which is beginning to form tubers; and finally, the long, tuberiferous one in figure 2, which terminates into an aerial shoot (St.). The youngest of these (S, fig. 2) shows the structure as follows. It is cylindric and glabrous, with a corresponding, cylindric stele (in cross-section) of sixteen collateral mestome-strands. The epidermis is thin-walled, and the cortex (C.) consists of about ten compact layers without starch and with only a very few cells containing the dark-colored substance. The endodermis is thin-walled, and shows the Casparyan spots very plainly, and has already begun to develop cork (figure 10.) Inside the endodermis is a single, continuous stratum of thin-walled parenchyma (P in fig. 10) surrounding a band of isolated strands of thin-walled stereome (St., figure 10.) The mestome-strands (figure 10) contain a wide duct in the leptome (D), a few layers of cambium, and a few spiral vessels. The broad pith contains no starch, but many of the cells are filled with the dark-colored substance. At the very base of this same stolon the cortical parenchyma shows numerous cells close to the endodermis filled with the dark substance. The only sign of a beginning of increase in the thickness is

indicated by the endodermis becoming a phellogen. It deserves notice that the thin-walled parenchyma which was first observed inside the endodermis in the swollen epicotyl, recurs in the young stolon. Furthermore, there is a small, very delicate tissue, "endoxyle," on the innermost flank of the hadrome, the further development of which will be described later.

In passing to describe the structure of the long, creeping stolon (figure 3), we might begin with the internode, marked A; the stolon is about three months old, and shows secondary growth very plainly. At this particular point, by A, the stolon is much thicker than those described above, (figure 2, S.) And the thickness is due to the many strata of cork, which have been developed from the endodermis, as heretofore push off the epidermis and the greater part of the cortical parenchyma, except the innermost two or three strata, which still persist and of which many cells show the dark-colored substance. There are twelve collateral mestome-strands with one to two ducts in the leptome, and with two to three porous vessels of considerable width. The broad pith is solid, but only a few of its cells contain the dark substance, mostly of a purplish color. The strands of stereome are small, isolated. The thin-walled parenchyma between these and the endodermis is very distinct. Secondary thickening is shown also by the mestome-strands, in which the cambium forms a zone of great width, and passing into a similarly highly developed inter-fascicular. The endoxyle mentioned above is still very little in evidence.

This same stolon, examined at the point marked B, which is just behind the very young, tuberous swelling, shows about the same structure. The cortex, however, is better preserved, and the epidermis has not been thrown off entirely. Cells with the dark-colored substance are rather numerous outside the endodermis, but there are very few in the pith. The cork is present only as a single stratum. The stereome represents an almost closed sheath inside the thin-walled parenchyma. The mestome-strands are smaller than in the former section. In other words the structure shows plainly, that the portion of the stolon is somewhat younger than the one at the point marked A.

While the parts examined (A and B) are from slender internodes, the part marked C is a young tuber, just beginning to be formed. Secondary roots have developed, and they are endogeneous. The stele is not circular in cross-sections, but approximately triangular or, in some places, quadrangular. The epidermis and the greater part of the cortex have been thrown off, but the cortex was composed of eight strata, and many cells outside the endodermis contained the dark-colored substance. Four layers of cork have been developed from the endodermis. The thin-walled parenchyma between the endodermis and the stereome is very distinct. The stereome is present as separate arches covering the broad leptome, in which the primary duct is still evident, besides one or two secondary ducts in the innermost part of the leptome. The hadrome contains about four vessels in two rays, with some few strata of libriform. The endoxyle is well represented showing many cell-divisions (Fig. 14.) The cambium occurs as intra- and interfascicular, the latter giving rise to small strands of leptome with a duct, but no hadrome, and no libriform were observed between the primary mestome-strands. The pith is rather narrow, solid and contains starch, but only a few of its cells contain the dark-colored substance.

Having thus described the structure of the young rhizome from the short, slender stolons to the long, creeping with the first appearance of the tubers, we will now pass to examine the mature rhizome, the slender and the tuberous internodes. Of these the slender portion represents, as stated above, only a part of an internode, since it actually extends to the swollen base of the tuber in front of it. And characteristic of this slender portion is the constant absence of roots, leaves, and lateral shoots, subterranean as well as aerial. The epidermis and primary cortex have become replaced by about eight strata of homogeneous, thin-walled cork, inside of which the thin-walled, parenchymatic stratum is still intact, and shows no cell-divisions. The stele shows a considerable increase in thickness of the mestome-strands, notably in the leptome, which contains now two concentric bands of ducts, the secondary being several together and of great width. Stereids occur as small, isolated strands outside the leptome, as well as scat-

tered within the leptome itself. The secondary hadrome shows several porous vessels of considerable width, partly surrounded by small strands of libriform with gelatinous cell-walls, and accompanied by long, narrow cells with small, rhombic crystals of calcium oxalate. Inside the primary, narrow vessels we observe the endoxyle forming a very delicate tissue with indications of tangential cell-divisions. Between the twelve mestome-strands, all making up a single, circular band (in cross-sections) we observe strata of thin-walled parenchyma forming very narrow rays between the hadrome parts, but extending considerably in width between the leptome-strands, and this parenchyma owes its existence to the interfascicular cambium, some few elements of which are still present, here and there. No secondary leptome nor ducts were observed in the periphery of this interfascicular tissue, or, let us say, of these medullary or parenchymatic rays. In the center of the stele is a narrow pith, compressed and linear (in cross-section), containing a little starch, and some few (12) cells are filled with the dark-colored substance.

Regarding the tuber, the structure has now attained its almost final development as to increase in thickness. The cork consists of numerous strata; the parenchymatic sheath has remained intact, as a single stratum with the cell-walls of exactly the same structure as before. The stereome shows the same position as before, corresponding with the collateral mestome-strands, which are now somewhat farther apart, but still represent a single band. The leptome contains two concentric bands of ducts, the inner one with several ducts situated close together and of great width. The hadromatic rays are deep, but narrow as compared with the leptome, and small scattered strands of libriform are much in evidence. Cambium is still present as intra- as well as inter-fascicular, and the medullary rays are quite broad. On the inner flank of the hadrome we find the endoxyle extending deeply into the pith as a narrow, radial ray (Fig. 13.) The pith occupies the greater part of the whole section, and contains large deposits of starch, but only a few cells contain the dark colored substance.

So far, we readily recognize the principal features of the

structure in the tuber, which were described as being characteristic of the rhizome in its younger stages. However a very essential structure is yet to be noted, one which is peculiar to the tubers alone. This structure depends on the presence of numerous small mestome-strands, which traverse the pith in various directions and which are especially noticeable in longitudinal sections. These mestome-strands contain always a wide duct with the epithelium of same structure as that of the ducts in the primary and secondary leptome; also some few stereids accompanied by cells with crystals of calcium-oxalate; a little leptome; and a few, very wide, porous vessels. The origin of these thin mestome-strands may be sought, at least to some extent, in the activity of the endoxyle, for several of the sections showed very plainly that the endoxyle had advanced so far in its further development that cambial strata, and some few elements of hadrome were differentiated. The endoxyle has been observed in many plants of the various natural families, and Russow is evidently the first author, who called attention to its existence. But it has been interpreted in different manners, for instance by Vesque as "liber mou rudimentaire," and Raimann, who called it "intraxyläre Cambiform" held the same opinion, considering it to represent a reduced, internal leptome. On the other hand, Solereder and Juel have referred this tissue to the hadrome. And whenever it occurs, the endoxyle is almost as a rule an inactive tissue which in Apios, however, stays dormant for some time only, attaining some activity at an advanced stage and to become the mother-tissue of new mestome.

With regard to the increase in thickness as exemplified by the tuber, this is effected by the secondary growth of the mestome, notably the leptome; by the pith, and to some extent also, by the advanced development of the endoxyle.

THE PEDUNCLE OF THE INFLORESCENCE.

When the flowers are beginning to open, the peduncle is cylindric with a corresponding cylindric stele (in cross-sections), and with a relatively narrow, solid pith. The cuticle is thin and smooth, and the outer cell-wall of epidermis is slightly thickened. Scattered unicellular, pointed hairs occur, but

they are generally much shorter than those upon the leaves. The cortex consists of three compact layers of roundish cells, containing chlorophyll, but no colored substance like that observed in the stem. There is a distinct endodermis, containing a little starch, and inside this is a continuous sheath of thin-walled stereids in about three strata. The thin-walled sheath of parenchyma, which in the basal portion of the epicotyl and in the rhizome is developed between the endodermis and the stereome is absent. The mestome-strands form a broad zone, containing large groups of leptome, each with a very wide duct, but with no stereids interspersed. The hadrome shows several wide, porous vessels, and some narrow, spiral ones inside; thick-walled parenchyma, the cells radially arranged, surrounds the vessels. The medullary rays are very narrow. The pith contains starch, and some of its cells are filled with the dark-brown substance.

We have mentioned the presence of a thin-walled parenchymatic sheath between the endodermis and the more or less continuous band of stereids in the subterranean part of the epicotyl and in all the internodes, slender as well as tuberous, of the rhizome. This sheath consists of a single stratum, and was never observed to develop any further, and we regret to admit, that we can not explain its function. And as may be seen from the preceding pages we have avoided using the term "péricycle" for this particular sheath as well as for the stereomatic. Some authors would undoubtedly refer both sheaths to a pericycle in the sense of Van Tieghem. A brief abstract of the history of the term "pericycle" may be appropriate at this place. Van Tieghem, who proposed the term, applied it to a parenchyma of one or several layers, which he observed in the stem between the endodermis and the mestome-strands, as well as in the roots between the endodermis and the outer face of the leptome, and between the endodermis and the proto-hadrome vessels. To the activity of the pericycle Van Tieghem ascribed the origin of the interfascicular arches of cambium with the subsequent development of secondary mestome-strands. Morot describing the pericycle in general, calls attention to the fact that while the pericycle is always present in roots (frequently called pericambium), it is not

always to be found in stems. He agrees with Van Tieghem, however as to the function of the pericycle. Gérard and Hérail question the assertion of Van Tieghem regarding the function of the pericycle in stem, and describe a number of cases, where interfascicular tissues develop independently of the pericycle. Moreover, Hérail describes some cases of secondary mestome being developed in the pith (*Melastomaceae* and *Campanulaceae.*) Finally Haberlandt makes no use of the term pericycle in stems, but only in roots; and in reference to the secondary increase in stems, this author speaks of a "cambium ring" being the direct product of a "procambium," and of an interfascicular cambium owing its existence to a meristem in the primary parenchymatic (medullary) rays. According to our observations we have never felt induced to consider the pericambium in roots and the so-called pericycle in stems as homologous tissues; as a matter of fact we have frequently observed the same conditions as those cited by Gérard and Hérail. And with regard to *Apios* neither the parenchymatic nor the stereomatic sheath correspond with a pericycle in the stricter sense of the word.

THE LEAF.

The petiole examined at the characteristic point, just beneath the lowest pair of leaflets, is almost cylindric with two narrow wings on the ventral face. The cuticle is smooth and thin; the outer cell-wall of epidermis is quite thick. The cortex consists of three compact layers with chlorophyll. There is no endodermis, but a continuous sheath of two to three layers of thick-walled stereome surrounds the main stele of several mestome-strands, in which the very broad leptome contains two to three wide ducts; between the mestome-strands are broad rays of thin-walled parenchyma. A single mestome-strand is located in each of the two wings, and surrounded by sterome. The pith in the main stele is hollow, and some few cells in the periphery contain the dark-brown substance.

THE LEAF-BLADE.

The structure is bifacial. Viewed in superficial sections the epidermis of the ventral face has the lateral walls strongly

undulate, but stomata are absent. Unicellular, pointed hairs follow the veins; and above the veins the epidermis consists of long, rectangular cells, each with a large, rhombic crystal of calcium oxalate. The dorsal epidermis shows the same structure, but stomata are present, and they are surrounded very regularly either by two or by four ordinary epidermis-cells. The pneumatic tissue shows very wide inter-cellular spaces, the cells being of an almost stellate shape. In transverse sections the epidermis is thin-walled, and the lumen wider on the ventral than on the dorsal face. The chlorenchyma consists of a single layer of high palisades covering three open strata of pneumatic tissue. The midrib contains some water-storage tissue on both faces and is also supported by an arch of stereome outside the leptome; the palisade tissue extends to the sides of the ventral group of water-storage-tissue, while no green parenchyma is located in the dorsal keel, formed by the midrib. Regarding the midrib itself, this consists of four separate mestome-strands, each with one or two ducts in the leptome; but in no part of the leaf-blade did we observe any cells containing the dark colored substance.

The structure of *Apios* thus shows several points of interest, for instance the abundant presence of stereome, as stereome s. s. as well as libriform in all parts of the stem, and accompanying the mestome in the leaves. We have also seen the never failing presence of the wide ducts with epithelium in the leptome, wherever this is represented, but in the leptome alone. The peculiar dark brown or purple content, by various authors described as tannin, does not consist of this matter, so far as we could observe; we found, as a matter of fact, no trace of tannin in any part of the plant. The distribution of these cells, containing this matter, varies somewhat in accordance with the parts examined. They are very numerous in the cortex of the aerial internodes, as well as in the pith; in the young stolons (S) there are only a few in the cortex, but many in the pith, while in the creeping, somewhat older stolons they are quite numerous in the cortex, but scantily represented in the pith; in the tuber they are abundant in the cortex, especially close to the endodermis, while the pith contains only a

very few. They recur in the pith only of the floral peduncle and in the petiole.

BIBLIOGRAPHY.

Briquet, J. Appareil vegetatif des Phrymacees, Stilboidees etc. Mem. Geneve. Soc. phys et hist, nat. de Geneve. Tome 32, 1896. See also: Atti Congresso bot. internaz. 1892.

Gerard, Passage de la racine a la tige. Ann. d. sc. nat. Bot. Ser. VI T. 15, 1881.

Gray, A. Manual of the Botany of the Northern States. New York 1857. p. 105.

Haberlandt, G. Physiologische Pflanzen-anatomie. 2nd ed. Leipzig 1896.

Herail, J. Recherches sur l'anatomie comparee de la tige des Dicotyledones. Ann. d. sc. nat. Bot. Ser. VII T. 2. 1885.

Juel, H. O. De tela fibrovasali *Veronicae longifoliae* L. Acta Hort. Berg. Vol. 2. Stockholm 1892.

Morot, L. Recherches sur le pericycle ou couche peripherique du cylindre central chez les Phanerogames Ann. d. sc. nat. Bot. Ser. VI. T. 20: 249, 1885.

Nypels, P. Observations anatomiques sur les tubercules *d'Apios tuberosa et d'Helianthus tuberosus.* Bull Soc. Roy de Bot. Belgique Vol. 31. Bruxelles 1892, p. 216.

Raimann, R. Ueber unverholzte Elemente in der innersten Xylem-zone der Dicotyledonen. Sitzungs-Ber. Wien Akad. Vol 98. Part I. 1889. p. 40.

Russow. Betrachtungen ueber das Leitbündel und Grundgewebe aus der Leitbündel-Kryptogamen mit Berücksichtigung der Histiologie der Phanerogamen. Mem. de l'Acad. imp. d. sc. St. Petersbourg Vol. 19. 1872.

Russow. Betrachtungen ueber has Leitbündel and Grundgewebe aus vergleichend morphologischem und phylogen. Gesichtspunkt. Dorpat 1875.

Sachs, J. Physiologische Untersuchungen ueber die Keimung der Schminkbohne (*Phoseolus multiflorus.*) Sitzungs-Ber. Wien Akad. Vol. 37. 1859, p. 57.

Seignette, A. Recherches anatomiques et physiologiques sur les tubercules. Thesis Paris 1889, p. 48.

Solereder, H. Systematische Anatomie der Dicotyledonen. Stuttgart 1899 p. 288.

Taubert, P. Leguminosae in Engler and Prantl: Die nat. Pflanzenfam. Vol. III. Part 3. Leipzig 1984. p. 72.

Torrey, J. Flora of New York. Vol. I. Albany 1843, p. 162.

Trecul, A. Recherches sur les laticiferes. Adansonia Vol. 7 Paris 1867. p. 113.

Trecul, A. Du tannin dans les Legumineuses. Ann. d. sc. nat. Ser. 5. Vol. 4. Paris 1865. p. 378.

Van Tieghem, Ph. Sur quelques points de l'anatomie des Cucurbitacees, Bull. Soc. Bot. France 29: 280. 1882.

Van Tieghem, Ph. Traite de Botanique Paris 1884. (pp. 281, 651, 744, 756, 809, 895.)

Warming, E. Om. Skudbygning, Overvintring og Foryngelse. Festskr. Naturhist. For. Kjoebenhavn 1884. p. 64.

EXPLANATION OF FIGURES.

APIOS TUBEROSA.

Figure 1. The seedling, natural size.

Figure 2. The rhizome; St.—base of aerial stem; S—two stolons; R—roots; two thirds of the natural size.

Figure 3. Another rhizome, showing the beginning formation of tubers upon the long, creeping stolon; the letters A, B, C indicate the places examined and described in the text; two thirds of the natural size.

Figure 4. A young tuber from the stolon in figure 3; enlarged.

Figure 5. Apex of a young stolon (S. in figure 2); enlarged.

Figure 6. The young tuber at C, upon the stolon in figure 3; enlarged.

Figure 7. Epidermis of lower face of leaf; x 360.

Figure 8. Cross-section of one of the secondary roots, marked R in figure 2; C—cortex; End.—endodermis; P—pericambium; St.—libriform; D—duct; x 480.

Figure 9. Cross-section of an aerial internode, showing the vessels and the endoxyle; x 480.

Figure 10. Cross-section of base of a young stolon; letters as above; x 480.

Figure 11. Longitudinal section of an aerial internode, showing the dark cell-content in cortex (C.) and endodermis (End.); x 360.

Figure 12. Cross-section of a mestome-strand from young stolon, (S in fig. 2) showing the duct (D) in the leptome, the cambium, and the hadrome; x 480.

Figure 13. Cross-section of a mature tuber, showing the inner part of the hadrome with libriform (St.), and the endoxyle; x 480.

Figure 14. Cross-section of the very young tuber (C. in figure 3), showing the innermost vessels, the libriform, and the endoxyle with cambial strata; x 600.

A New Helianthus From Kentucky.

FRANK T. McFARLAND AND W. A. ANDERSON, JR.

Kentucky, because of her geographical location and her geological formations, offer to the present day botanist an excellent opportunity for the study of the plant distribution and the probable geographical extension of many species not now credited by the Seventh Edition of Gray's Manual.

Since 1912 the senior author has been studying the range of the phanerogams and pteridophytes of the state. Most of the state has been covered with the exception of two localities, one being in the extreme Northeastern part of the state south of Ashland, and the other in the southern part of the state just south of Somerset and to the Tennessee border. These two regions have never been visited by a botanist so far as the writers are aware. No doubt these two regions, which represent virgin conditions, when worked over, will yield many new and interesting things.

During August and the early part of September 1923, the writers in company with two assistants, J. B. Taylor and S. L. Dorsey, spent their time in working over that part of the state lying west of the Tennessee River which is generally known as the Purchase Region. From the first, it was the intention of the party to make an ecological survey of these eight counties, but finding the territory too large to cover in the time available, plans were modified so that all the time was taken in making collections of plants.

Wickliffe, on the banks of the Mississippi River was chosen for the first station, largely because of the extensive sloughs and cypress swamps. This region proved to be very interesting and many plants not reported for the state were found. After spending ten days at this station, camp was moved to Clinton, Ky., a beautiful little town, thirty miles south and about twelve miles from the Mississippi. This region being higher and drier proved to have less of the malarial mosquito, which was very abundant and troublesome at Wickliffe. The

PLATE X.

country about Clinton was quite thoroughly covered by automobile and here many heretofore unreported species were collected.

East of Clinton, the land is gently rolling while to the west, the land is more rugged. Owing to the greater diversity of the topography of this region west of Clinton, we found collecting very good. On the 24th of August, while on our way to Columbus, one of the party discovered by the roadside a plant which at first was taken for a Silphium. Specimens were collected and taken to the laboratory and on investigation, proved to be a true Helianthus. After spending much time in trying to locate it in the various manuals and without success, specimens were sent to Mr. E. E. Watson, Michigan Agricultural College, East Lansing, Mich., Mr. Watson acknowledged the receipt of the specimens and in his reply, said that the specimens were different from any that he had worked over, and that the plant was apparently an undescribed species. This was the same conclusion that the writers had come to before submitting the plants to Mr. Watson. We feel that this plant is so strikingly different from any of our described species that we feel justified in reporting this plant as a new species.

This sunflower which we propose to name *Helianthus kentuckiensis*, The Kentucky Sunflower, was found growing on a sandy clay bank along the roadside, six miles west of Clinton, on the Clinton-Columbus road. The black, knotty, woody roots as well as the very strigose stems and leaves will serve readily to identify it in the field. (See Plate No. X.)

Helianthus kentuckiensis, n. s.

Planta perennis cum ligneis nodosisque rhizomatibus; caulis strigosissimus sparse ramatis supra, 1.6-2.3 m. altus: foliis firmissimis, crassis, denticulato-crenulatis, ovatis-deltoideis, triplinervatis, duabus faciebus scabrosissimis, truncatis pilis ad basim glandulosis, 10-12 cm. longis, 7.5-10 cm. latis, infimis oppositis, superis alternis et minoribus: petiolis anguste alatis, 2-3 cm. longis; capitulis paucis 2-4, ramos terminautibus,

---

* Contribution No. 7, Department of Botany, University of Kentucky.

prope 3.5 cm. latis. Involucrum hemisphericum, bracteis imbricatis 3 vel 4 in seriebus, obtusis, mucronatis ciliatis scabrosis; pilis tenuibus ciliatis; disco conico crebro. Floribus discoideis, fulvo-purpurascentibus, radiis 12-14, flavis et acutis; achensiis quadrangulatis, pilosis, circulo cum brevibus ciliis in summitate. Pappus duobus brevibus tenuibusque paleis, indutus margine ciliato, 2 mm. longa.

Habitat in solo arido siliceoque per viam ex occasu venienti sex milia passum ab urbe Clintonensi, Ky., in via Columbana.

Floret mense Augusto et Septembri. Nota est ex solo loco suo. Exemplar in Herbario McFarlando, No. 374. Exemplaria similia adsunt.

In Herbario Nationali, Washington, D. C.

In Herbario Universitatis Kentuckiensis, Lexington, Ky.

In Herbario Universitatis Harvardensis, Cambridge, Mass.

In Herbario Missouri Botanici Horti, St. Louis, Mo.

In Herbario Universitatis Nostrae Dominae, Notre Dame, Ind.

DESCRIPTION:

Helianthus kentuckiensis new species

The Kentucky Sunflower.

Perennial by woody, black, knotty rootstocks; stems sparingly branched above, very strigose, 1.6-2.3 m. high. Leaves very firm, thick, denticulate-crenulate, ovate-deltoid, the acute base truncate to slightly cordate, triple nerved, very scabrous on both sides, each hair rising from a glandular base; 10-12 cm. long, 7.5-10 cm. wide, the lower opposite, the upper alternate and more or less reduced in size; petiole narrow winged, 2-3 cm. long; heads few, 2-4 at end of each branch, approximate, 3.5 cm. broad; involucre hemispherical, bracts imbricated in 3 or 4 rows, obtuse, mucronate, ciliate and scabrous; chaff thin, ciliate; disk low-conic; disk flowers purplish brown, rays 12-14, chrome-yellow, showy, pointed; achenes quadrangular, somewhat hairy on the faces with circle of short hairs at the crown; pappus consisting of two short thin awns, ciliate on margin, 2 mm. long.

Habitat: In dry sandy clay soil along roadside six miles west of Clinton, Ky., on the Columbus road.

Season: Late August and September.

Known only from type locality.

Type in McFarland Herbarium No. 374.

Co-types are deposited in:

Herbarium National Herbarium, Washington, D. C.

Herbarium Missouri Botanical Garden, Saint Louis, Mo.

Herbarium University of Kentucky, Lexington, Ky.

Herbarium Harvard University, Cambridge, Mass.

Herbarium University of Notre Dame, Notre Dame, Ind.

University of Kentucky.

BOOK REVIEWS

In this section are reviews of new, or particularly important and interesting books in the fields of natural science. Books dealing with botany or kindred subjects should be sent to the Editor, the University of Notre Dame. *All other books for review* should be sent to Carroll Lane Fenton, at the Walker Museum, the University of Chicago, Ill. Publishers are requested to furnish prices with books.

THE OUTLINE OF SCIENCE, edited by *J. Arthur Thompson*. American edition, in four volumes, published by G. P. Putnam's Sons. $4.50 per volume.

The most astonishing thing about this set of books is the fact that a publisher had sufficient confidence in the general educated public to undertake the task of getting out "The Outline of Science." For the deslike of the educated public for anything that might educate it more is so old as to be proverbial, and no publisher can flourish on dislikes for the things which he publishes. But evidently things with the public are not so bad as they used to be. Wells' badly conceived "Outline of History" has long since passed the quarter million mark, and Van Loon's infinitely better "Story of Mankind" is in its 110th thousand. I do not know the sale of Thompson's "Outline" but Mr. Putnam seems to be pleased.

The first volume appropriately enough, begins with a survey of the universe in general, and our solar system in particular. The author is very uncertain as to how the solar system developed; he appears to favor the Planetesimal hypothesis, but I suspect that, like most Englishmen, he is unable to break away from the gaseous ball of Laplace. Evidently there is need for some popular book that will, once and for all, disabuse the popular mind of Laplaceism, for until that is done there can be no clear thinking on either geology or zoology. It is a pity that Dr. Thomson did not attend to the job.

The chapters on the history of the earth, and the development of life are clear and interesting, as is also the section of "Adaptations to Environment." "The Struggle for Existence," too, comes in for a treatment quite proportionate to the position it holds in general interest. The chapter dealing with the ascent of man is less satisfactory; one gets the impression that the writer was none too sure of himself, and was afraid that he might tell too much. Mr. Wells has done much better. But the section on the "Foundations of the Universe," which deals with everything from theories of electrons to wave action, suffers from neither haziness nor undue abbreviation. Perhaps I got a special pleasure from it because of my general ignorance regarding chemistry and physics. But I am quite sure that my ignorance is not greater than that

of most folks who will read the book, so my liking for the chapter is sustained.

The most striking portion of the second volume is the three chapters devoted to natural history,—birds, mammals, and insects. They are admirably written and better illustrated; they tell what is important to know, and omit the abundant anecdote that used to clutter the pages of natural histories. Other chapters,—on botany and the lower vertebrates—are given in the third and fourth volumes, along with discussions of more fundamental or general topics, such as biology, characteristics of living creatures, and so on. It is hard to see the advantage of such a treatment, at least when one has been accustomed to the meticulous order of Parker and Haswell and of Hertwig. I should like to see a more compact arrangement of the natural history material—indeed, I should like to see it put into one volume, with all the necessary pictures, and issued separately. The old time natural history made famous and also infamous by the Reverend Wood, appears to be thoroughly dead. It has disappeared from the book shelves in schools, and from the counters in stores, and the pages of the mail-order catalogue. And so far there has been nothing to take its place. Mr. Duncan's big volume, published in England by Cassell and in America by Funk & Wagnalls is too nearly a zoology to please or interest the average youngster. He looks at its pictures, but he does not read its too systematic and informing pages. But the natural history sections of the Outline he would both look at and read, but to own all of them, he or his father must spend $13.50. And there are many youngsters, and many schools and libraries, to whom the spending of $13.50 is an almost unheard-of thing. $4.50 they could manage, but three times that sum is too much.

But it is not the function of a reviewer to give financial advice to publishers who are so kind as to send him books; they are capable of attending to that themselves. Yet when a reviewer honestly likes a book, honestly thinks that anyone between the fifth grade and a Ph. D., can learn many things from it, he may be justified in allowing his enthusiasms to run free. For I feel just that way about the "Outline of Science"; that it is a valuable work for the library, the youngster, the professional or business man, and the scientist. Of course, there are some things about it I do not like, but there are many more that I do. I might complain because there is a chapter on psychic "science" by Sir Oliver Lodge, and opine that Mrs. Eddy, Pastor Russell, and W. G. Voliva should have their share too. Yet Mr. Lodge's chapter is interesting, and the person who has brains enough to read the 564 pages that precede it will not be seriously damaged by Mr. Lodge on telepathy and clairvoyance. I might complain loudly about the treatment of the origin of the earth, but I find it more to the point to praise such chapters as the "Story of the Rocks", the "Romance of Chemistry", and so on. For every unsatisfactory thing about the books there are

hundreds of features of astonishing goodness. For every bad picture there are fifty very, very good ones, and even the worst are far better than the average in other books. I do not, of course, agree with the London Morning Post when it proclaims the "Outline to be so accurate that the expert cannot cavil at it, so simple that the general reader, who has no time for special study, can understand it." Experts can and will cavil at any book, excepting perhaps the one they write themselves, and no book so big and so all-inclusive as this can hope to be perfect. But Dr. Thomson's comes surprisingly close to the mark, and stands as far and away the best popularization of science in print.

C. L. F.

NATURE MAGAZINE, edited by *P. S. Risdale* and *A. N. Pack*. Monthly, published at 1214 Sixteenth Street, Washington, D. C. $2.00.

The first number of this excellent magazine appeared in the middle of January, and the second appeared promptly a month later. It is published by the American Nature Association, which appears to be sustained largely by the magazine. Subscription carries with it membership in the association. Aside from the magazine, the principal advantage derived from membership appears to be the opportunity to participate in the organization's book-buying service. This service procures for members any book on natural science in print, sends it postpaid, and allows a discount of ten percent. If one buys many books, that discount is apt to be important.

The magazine itself is strictly popular—somewhat on the order of the old "Birds and Nature", long since defunct. The articles are short, the longest in the February issue taking up less than five pages. There are abundant pictures, admirably printed. The editors appear to be specially anxious to secure justice for snakes, and have several very good snake photographs. All in all, the "Nature Magazine" appears to be a highly worth while publication, that deserves a wide circulation among town and school libraries, and in homes where there are children to be interested in wild things.—C. L. F.

MAN'S PREHISTORIC PAST, BY HARRIS HAWTHORNE WILDER. The Macmillan Co.

ANCIENT MAN IN BRITAIN, BY DONALD A. MACKENZIE. Frederick A. Stokes Co.

Had Professor Wilder succumbed to the recent craze for "Outlines" he probably would have titled his book "The Outline of Prehistory." But this professor of zoology who is able to make even comparative anatomy interesting has too much individuality to fall under the spell of fads, and it must be admitted that he has done excellently.

For "Man's Prehistoric Past" is more than an outline: it is a simple but astonishingly complete elementary treatise. From the first chapter on "The Chronology of Prehistory" to the last, dealing with "Known Types of Prehistoric Man" the book is neither hasty nor unbalanced—

both traits which we have come to expect in "Outlines." Nor are there many obvious errors; in fact, for the reader who is not a specialist in anthropology to point out a single one would be difficult. On points of theory, of course, there is no such infallibility; Professor Wilder follows Keith rather than Osborn, so that the older styles of archeologists will not always agree. But then, complete agreement is very apt to be the death of theory....

But perhaps it is unfair to pass judgment—even favorable judgment—on a book without first telling its scope. The first chapter, as I have intimated, gives a general survey of the time elements involved in the study, and the manner in which they are worked out. This is a field that often puzzles the educated layman: how do archeologists *know* that one race lived before some other, when they inhabited some quite distinct portion of the globe? Dr. Wilder answers such questions with a thoroughness that should satisfy even such men as Professor Price, who would have dinosaurs, trilobites, and coal-measure amphibians all romping about the earth at one time.

The chapter on "Materials and Methods" is to some extent an elaboration of the one on chronology, and is by all odds the clearest statement of the archeologic mode of operations that I know. There is nothing startling and new in it, of course; new things do not often get into elementary books, since they are very apt to be out of place. The same applies to the chapters on prehistory, which cover all of the continents except Antarctica, where prehistory is unknown. Perhaps the most imposing of them is the one on North and South America, continents which usually are slighted in discussions of ancient man. Writers seem to think that because the Aztecs were by no means so ancient as the Cro-Magnards they were far less important and interesting—a conclusion that is gravely to be questioned. The significance of a relic does not always depend upon its age, and it is quite possible that the genetic sociologist will learn more from the American Indians than he will from the bones of Mas d' Azil. And it is by no means the least significant thing about Dr. Wilder that he considers the needs of the genetic sociologist....

* * *

The reader will find the same breadth of view and interest in Mr. Mackenzie's study, "Ancient Man in Britain." The book "deals with the history of man in Britain from the Ice Age till the Roman period. The evidence is gleaned from the various sciences which are usually studied apart, including geology, archeology, philology, ethnology or anthropology, etc., and the writer has set himself to tell the story of ancient man in a manner which will interest a wider circle of readers than is usually reached by purely technical books."

A promising introduction, and in the main it is borne out in the body of the book. Of course it bears the stamp of Mr. Mackenzie's particular interest, which happens to be mythology, and it readily becomes evident that he is trying to interest those of us who prefer the geological or

purely archeological aspects of ancient man and care little for his mythology. The process is simple: Mr. Mackenzie merely demonstrates that by linking mythology, philology, geology, and archeology together one gets a full and remarkably reliable picture of the daily life of ancient man, while otherwise he gets but a partial representation.

The actual structure of the book is disappointing. In more than one instance the author has lost sight of that cardinal principle of expository writing—the telling of what one is going to show and the showing of it, terminated by a brief statement of what has been shown. Nor does he retain uniformity in organization; the early chapters are based on chronology and the late ones on subject material. Thus the first chapter is entitled "Britons of the Stone Age;" the second "Earliest Traces of Modern Man;" the third, "The Age of the 'Red Man' of Wales"—all clearly in sequence. But when the popular reader, to whom Mr. Mackenzie makes a strong appeal, has passed through these chapters he comes upon others on such subjects as "The Lore of Charms," and "Ancient Pagan Deities." Unless he has a more thorough knowledge than is to be found in most general readers, he will have a good deal of trouble tying this information together. For, it must be remembered, (though it generally isn't), this non-technical reader is a man who earns his living in an office, a store, or a factory, or by teaching unity, coherence, and emphasis to college freshmen. And when he gets through with his day's work and is ready to read, he has no time to make elaborate preparations—or even simple ones. He does not have to be spoon-fed, but the path of his inquiry should be made smooth, and that is not done sufficiently well of "Ancient Man in Britain." Yet were I asked to recommend a better book on the subject.... well, I'm thinking that Mr. Mackenzie has surpassed his peers, if not himself.

—CARROLL LANE FENTON.

PIERRE CURIE, BY MARIE CURIE. The Macmillan Company. $2.25.

In this book we have a simple biography, to which is appended a simple autobiography, that covers the lives of two great scientists. One is reminded of Mme. Curie's response when the writing of such an account was urged upon her. "Oh, but it will not be much of a book.... it is such an uneventful, simple little story. I was born in Warsaw of a family of teachers. I married Pierre Curie and had two children. I have done my work in France."

Perhaps it is an uneventful story.... like the story of almost any other scientific existence. But that does not mean that it lacks pathos and heroism. For it is not easy and pleasant to do great work on small pay and with defective and even dangerous apparatus. Our dollar-worshipping magazines have published page after page of cheap sentimentalization over Marie Curie and her husband, toiling in a Paris shed in order that they might discover a new element of tremendous importance. We Americans have an endless appetite for such

whang-doodle, and it tickles our fancy to imagine the great scientist doing great things in a hovel. Probably the French feel a good deal the same ... or they wouldn't have left the Curies to labor in a shed. And then, after taking from this little woman and her dead husband knowledge that is priceless, we felt tremendously virtuous over the gift of a hundred thousand dollars worth of radium. Perhaps we should feel virtuous; France chose to invest its money in warfare against new governments, to make necessary more radium.

Thus it is that I do not read this story of Pierre Curie's life of investigation and teaching without resentment, though I hasten to admit that there is none in the book. For both of the Curies their work, their love, and their home sufficed. And that is the spirit of this book.

—C. L. F.

WESTERN BIRDS, BY HARRIET WILLIAMS MYERS. Second Edition. The Macmillan Co.

This second edition of Mrs. Myer's book does not differ greatly from the first, but such changes as are to be found are in the way of increased usefulness. She still is on rather strained terms with the English language, particularly in the matter of relative clauses. But amateur bird students seldom are meticulous in their selection of composition.

The text is highly pleasing. Handbooks like Mrs. Bailey's are too obviously intended for identification to make pleasant reading, and there is many a beginning ornithologist who finds Chapman dull. By combining necessary descriptive material with a readable account of habits, range, and abundance Mrs. Myers overcomes this difficulty, thus making her book one that will attract as well as instruct. The accounts are not quite so pleasing as those of Neltje Blanchan's "Bird Neighbors," but they are far from dull. The numerous photographs of birds on the nest are attractive, though it might have been well to supplement them with a series, either of photographs or of drawings, that would be useful in identification. It is in such pictures that one finds the enduring value of the none too reliable Reed Guides, and the addition of similar ones, even in black and white, would add greatly to the usefulness of "Western Birds." But even without them it is a book that every nature student west of the Rockies—and many east of them—will find of great help and interest.

—C. L. F.

The American Midland Naturalist

PUBLISHED BI-MONTHLY BY THE UNIVERSITY
OF NOTRE DAME, NOTRE DAME, INDIANA

VOL. IX. JULY, 1924. NO. 4.

Euphorbia Marilandica Greene.

THEO. HOLM.

(*With 2 plates drawn from nature by the author.*)

Among the numerous species, discovered and described by Greene, *Euphorbia Marilandica* is one of the most interesting. Greene was himself under the impression that its real affinity was somewhat doubtful, for although he considered it to be an ally of *E. corollata L.*, the habit appeared very distinct, simulating certain species of the *Anisophyllum*-section of the genus. The original diagnosis published in Pittonia (III-345, 1896-1898) reads as follows: "Perennial, with green glabrous glaucescent herbage, the bushy trichotomous stems about one foot high from long horizontal roots or rootstocks running only a little below the surface of the ground: leaves 1½ inches long, the lower in whorls of three (corresponding to the trichotomous branching); those of the loose inflorescence reduced to (opposite) subulate white-tipped bracts; all the proper foliage lance-linear, entire: involucre as in *E. corollata* but smaller, the appendages more nearly orbicular: fruit not seen. Common along the sand-hills of Anne Arundel County, Maryland, about ten miles south of Baltimore. An ally of *E. corollata,* but wholly distinct from that species by its vegetative characters, and by the root being horizontal and quite superficial cet. In its low bushy spreading habit the plant simulates certain species of the *Anisophyllum* section of the genus."

So far as concerns the plant from said locality the diagnosis is correct, but, as will be shown in the subsequent pages, the habit, notably the ramification of the shoot, is quite variable, besides the color of the appendages of the involucre. We

have found the species near Clinton, Md., in sandy, gravelly soil, cleared woodland. It is rare in this vicinity, growing very scattered, and is always associated with *E. Ipecacuanhae* L., and blooming at the same time. *Euphorbia corollata* is also very frequent, but grows mostly in a more sandy soil, in open fields, and blooms much later. When we found the plant, our first impression was, that it represented a hybrid between *E. Ipecacuanhae* and *E. corollata;* a closer study and continued observation have convinced us that it is so. However, we did not reach this conclusion before we had studied the supposed parental species more closely, inasmuch as these are also quite variable, wherever they occur.

When comparing *E. Marilandica* with the two other species, mentioned above, the difference and resemblance depend principally upon the ramification of the shoot, the structure of the foliage, and the presence or absence of involucral appendages. To facilitate the comparison we might offer a brief description of the supposed parental species before outlining the characteristic structure, the external as well as the internal, of the supposed hybrid. However, since the floral structure of *Euphorbia* has been a subject very much disputed, we might at first present a recapitulation of the various data, "pro et contra" the most generally accepted theory that the cyathium is an inflorescence, not a flower.

THE CYATHIUM OF *EUPHORBIA*.

The term "cyathium" [1] applies to the inflorescence of *Euphorbia,* where the staminate and pistillate flowers are grouped in a flower-like inflorescence. As shown by Warming in his excellent thesis (1871) [2] the earliest definition by Linné, according to which the cyathium should represent a flower, was brought to light again and eagerly defended by Payer (1857) and Baillon (1858), although Robert Brown (1814) had so very clearly demonstrated, that the cyathium is actually an inflorescence, and his view having been generally accepted by the leading botanists.

[1] Syn. Cyamium Drejer, Syzyganthium Petermann.

[2] For references consult the bibliography appended.

Linné described *Euphorbia* as follows: "Polyandria monogynia. 517. *Euphorbia.* Cal. Perianthium monophyllum.... ore quadridentatum (quinquedentatum paucioribus) persistens. Cor. Petala quatuor (quinque paucis) turbinata, gibba, crassa, truncata, situ inaequalia, cum dentibus calycis alterna, unguibus margini calycis imposita, persistentia. Stam. Filamenta plura (duodecim vel supra), filiformia, receptaculo inserta, corolla longiora, diverso tempore erumpentia. Antherae globosae, didymae. Pist. Stylus simplex, brevis. Germen subrotundum, triquetrum. Stigmata tria, semibifida. Per. Capsula subrotunda, triloba, trilocularis, stylo elongato pendens."

This explanation was accepted for some years until Lamarck and A. L. de Jussieu suggested, that the cyathium might represent an inflorenscence; the calyx and corolla, defined so by Linné would thus be an involucre; each stamen a male flower, and the pistil a female flower; furthermore the small, laciniate scales should represent the sepals of the male flowers (Lamarck). Finally Robert Brown unreservedly declared the cyathium to be an inflorescence. He agreed with Lamarck and Jussieu, that "what Linnaeus has called calyx and corolla in *Euphorbia* is an involucrum, containing several male flowers which surround a single female." He also agreed with these authors, that the male flowers are monandrons, but the body, which is described as a jointed filament, Robert Brown considered this "to be made up of two very distinct parts, the portion below the joint being the foot-stalk of the flower, and that above it the proper filament; but as the articulation itself is entirely naked, it follows that there is no perianthium; the filiform or laciniated scales which authors have described as such, being on this supposition analogous to bracteae. The female flower, in conformity with this supposition, has also its pedunculus, on the dilated, and in a few cases obscurely lobed, apex of which the sessile ovarium is placed." A few years afterwards, in 1817, Robert Brown made the supplemental statement as follows: "I am now enabled to add the more direct proof derived from certain species of Euphorbia itself, in which the female flower is furnished with a manifest calyx. I have formerly observed, that in a

few cases the foot-stalk of the ovarium is dilated and obscurely lobed at top; but in the species now referred to it terminated in three distinct and equal lobes of considerable length, and which being regularly opposite to the cells of the capsule may be compared to the three outer foliola of the perianthium of *Phyllanthus*, between which and the cells of the capsule the same relation exists."

The principal difference between the definition given by Robert Brown and the one by Lamarck and Jussieu is thus, that the male flower becomes restricted to the stamen itself, while the portion beneath the articulation represents its stalk; the scale-like bodies "les écailles ou languettes frangées interposées entre les faisceaux d'étamines" (Lamarck) should then be the bracts of the staminate flowers, instead of sepals. Adrian de Jussieu (1823) reached the same conclusion as Robert Brown, based especially upon the allied genus *Anthostema* Juss. Furthermore Johannes Roeper (1824) confirmed the observations by Robert Brown, and he added several interesting points to these, with regard to the ramification. He pointed out more definitely that the male flowers are arranged in five groups opposite the lobes of the involucre; but he explained the origin of each group as depending on "rami accessorii" in the axils of the leaves of the involucre, the bracts thus representing their two prophylla, an opinion quite different from the one expressed by Robert Brown and Adrian de Jussieu. Several years later some interesting papers were contributed by H. Wydler (1843-1851), and he was the first author to describe the inflorescence of the staminate flowers as five scorpioid cymes situated in the axils of the involucral leaves; the bracts (Robert Brown) thus representing the "actual bracts of the single flowers."

The cyathium became gradually accepted as the structure of the inflorescence in *Euphorbia*, and we find it as such in the leading botanical works of Europe (Kunth, Endlicher, Lindley, W. J. Hooker, Parlatore, Grenier et Godron, De Candolle's Prodromus etc.), and of America (Asa Gray). Nevertheless Payer (1857) and Baillon (1858), having made an extended study of the genus from a developmental point of view, insisted that the definition given by

Linné was the only correct one: the cyathium being a flower with a single perianth, with five compound stamens, and one pistil. The thesis of Warming cited above, contains a very detailed discussion of the value of the different points brought out by the French authors, based upon his own observations on fourteen species of the genus. But even when considering the structure of the cyathium from this new point of view, the developmental, Warming was unable to trace any facts, that did not harmonize with the definition proposed by Robert Brown, so far as concerns the most essential points. At that time Warming considered the stamen in *Euphorbia* to represent a pollen-bearing caulom, since it is terminal; this view he changed, however (1877) in conformity with Celakovsky and Mueller Argov., thus accepting the possibility of the existence of terminal phylloms.

In a subsequent paper (1872), dealing with the ramification, and the bifurcation of the growing point in phaenogamous plants, Warming devotes a large chapter to *Euphorbiaceae*, presenting some additional data about the much disputed cyathium. Among these we notice, that the small, scale-like organs, situated between the male flowers, which Robert Brown defined as bracts, are by Warming referred to trichomes; in his thesis these organs are classified as being intermediate between phylloms and trichomes, although most probably trichomes, having become developed in the place of leaves, thus analogous with the pappus in *Compositae*. Payer and Baillon defined them as "dépendances du disque." They are described as being destitute of vessels, which would not, however, be against their possible foliar nature, since many leaves, notably bracts, and sterile stamens (*Compositae*) have no vessels. They are discussed again in the second paper (1872), where Warming mentions, that they show the nature of trichomes by their irregular structure, besides that no vessels could be detected in cross-sections of these organs.

The views expressed by Payer and Baillon were approved by R. Pedersen, about a year after the publication of Warming's thesis. According to R. Pedersen the most important point depends upon the morphological identity of the stamen. Payer defined this as a leaf; Baillon defined each group of

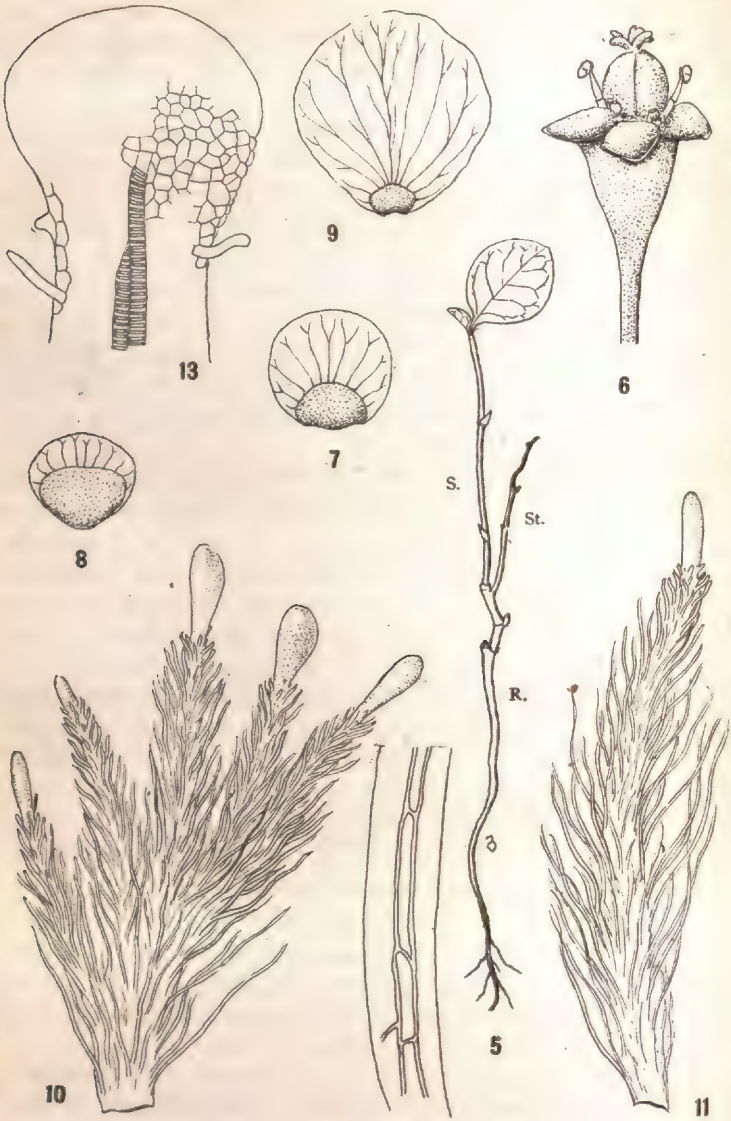


PLATE XI.

stamens as a leaf, each stamen thus representing a leaflet or a lobe, while Warming considered the stamen as an axis. The main point is thus to prove that the cyathium really contains several axes, which would be in favor of Robert Brown's theory: an inflorescence, or only one, which would support the definition proposed by Linné and Payer: a flower. It is now interesting to read the objections raised by R. Pedersen, and one of these reads: "it has never been proved that the 'bracts' are leaves," "they never contain vessels." The result of the investigation made by R. Pedersen, is: "the cyathium is a flower." Finally Schumann (1890) did also examine the development of the cyathium, reaching the conclusion that the development resembled that of a flower, but admits that the other definition does deserve consideration.

We should not have ventured to present this long recapitulation of the views expressed regarding the structure and consequent definition of the cyathium, if it were not for the fact, that we have observed some additional evidence in favor of Robert Brown's theory. While studying Euphorbia Ipecacuanhae, we examined of course the much disputed "bracts" (Robert Brown), which were discovered by Lamarck: "écailles ou languettes frangées interposées entre les faisceaux d'étamines." The fresh material, which was copious indeed, proved highly interesting. These little organs are colorless except at the apex, which is of a somewhat greenish-yellow color; they are most frequently laciniate (Fig. 10), seldom entire (Fig. 11), but in both forms the epidermis is extended into numerous long, pluricellular (one row) hairs, decreasing in length towards the clavate, obtuse apex, which is free, uncovered. Our material was only treated with caustic potash and glycerine. The numerous long hairs, which formed a dense coating around these organs, rendered the examination somewhat difficult, but, nevertheless, laticiferous, anastomosing ducts (Fig. 12) and spiral vessels (Fig. 13) could be seen in many of these organs. The abundant material finally yielded many very fine preparations, where the hairs rendered no obstacle, and we now saw very plainly several, from 2 to 5 spiral vessels forming a strand from the base to near the apex (Fig. 13) of these organs, and accompanied by a net work of ducts.

This structure recurred in nearly all the larger bracts examined, the vessels, however, only in the larger, central laciniae, while the ducts could also be seen very plainly in the lateral. The simple, entire bracts (Fig. 11) were not seen to contain vessels or ducts. In other words these organs do exhibit a foliar structure, even if their shape is not exactly regular. Hairs containing vessels are well known, for instance in *Drosera,* but trichomes with anastomosing laticiferous ducts do not seem to be known; those of the *Cichoraceae* contain only a single duct, as shown by Solereder (p. 517. fig. 0.), being the direct continuation of the system of these ducts. The shape of these organs resembles that of the fringed apex of the lobes of the cyathium, besides the stipules in some of the species of the genus. We believe that they actually represent bracts, but not developed uniformly, some being simple, others laciniate, and broader, but otherwise of the same length throughout. In other words the term "bracts" seems correct, and subtending the axes bearing the stamens, the cyathium thus contains several axes, including that of the pistillate flower, and is consequently an inflorescence.

EUPHORBIA IPECACUANHAE.

A member of the section *Tithymalus* according to De Candolle (Prodromus XV: 101, 1866), and two forms are described "*portulacoides*" foliis infimis latioribus orbiculari-ovatis saepe retusis (Pursh), and "*gracilis*" foliis lineari-lanceolatis vel linearibus (Elliott.) Of these the former is *E. portulacoides* L. (Amoen, acad. III:117, 1756), the latter *E. Ipecacuanhae* L. (ibidem: 116). Gray has only *E. Ipecacuanhae,* but mentions the variation in foliage; on the other hand, the species is referred to the section "*Tithymalus* without stipules," which is not correct, since stipules are actually present.[1]

With regard to the inflorescence the cyathia are arranged in cymes of the dichasium-type, passing, occasionally, into a monochasium. Variation in this respect may occur in the same specimen, in the basal and apical branches, but two characters remain constant: the long peduncle of the cyathium

[1] Compare Merck's Report: 1909, p. 115.

and the first rays of the inflorescence being developed from the axils of relatively small sessile, bract-like leaves, while all the upper leaves are larger and petiolate. The latter structure must be especially characteristic of *E. Ipecacuanhae,* for according to Pax, who describes the inflorescence of *Euphorbia*: "Die ersten Verzweigungen der Euphorbien-Inflorescenz geschehen durchweg aus der Achsel von Laubblättern und erst an den letzten Strahlen werden die Blattorgane etwas hochblattartig." It is very different with regard to *E. Ipecacuanhae,* for in this species the very short, more or less subterranean, ascending stems bear only two or three pairs of small, scale-like leaves preceding the inflorescence. All the axes, the primary as well as the secondary and tertiary, are terminated by a long-pedunculate cyathium. According to Pax a pleiochasium, dichasium and monochasium occur in the genus. The pleiochasium is rare in *E. Ipecacuanhae;* it depends mostly upon the development of three bracts, forming a whorl at the base of the primary or secondary cyathium, a "trichasium;" Pax, however, uses the term pleiochasium, when more than two rays are developed. In some specimens the basal, partly subterranean leaves (two to five), were scattered, and each subtending a shoot terminated by a cyathium with two large, opposite leaves, while the apex of the main axis was terminated by a cyathium with three large, green leaves, from the axils of which three dichasia were developed. Specimens showing this ramification were unusually large and late blooming (June 14th.)

Monochasia are not rare; they are as a rule, however, confined to the lateral shoots of first order, and are terminated by a cyathium with two opposite leaves, but of which only one leaf subtends a vegetative shoot. In inflorescences of that type, monochasium, the leaves at the base of the uppermost (secondary) cyathium are of very unequal size, the barren being the smaller. This structure may occur together with typical dichasia, dichasia throughout, in the same specimen, and even if such specimens were quite frequent, the majority of the inflorescences were true dichasia. Typically the leaves are opposite, but, as stated above, the lowermost leaves of the

main axis may sometimes be scattered; they are constantly much smaller than the succeeding, opposite.

The shoots, numerous from the same rhizome, are prostrate, but the cyathia are held in a vertical position. Characteristic of the species is the continued growth of the internodes and the foliage after the fruit has matured, and they may be found perfectly fresh late in the fall. In the variety *gracilis*, for instance, the length of the first internodes may average only about four cm., and the leaves only ten mm. in length and six mm. in width at the time of flowering, while during the fall, the length of the whole shoot may average about 17 cm., and the leaves 5.5 cm. in length, and 6 mm. in width. The variety *portulacoides* is quite a large plant during the fall, the shoots attaining a length of 30 cm., the leaves 2 cm. in width, and 4 cm. in length. The normal time of flowering is, in this vicinity, April, but some years ago, we observed numerous specimens in full bloom as late as July; this was in a tract of cleared woodland.

The seedling stage of *Euphorbia Ipecacuanhae* does not seem to be known, and we have never succeeded in finding this stage in nature, nor did any of the numerous seeds germinate, which we sowed, and kept in the open for more than a year. Young plants are not uncommon, however, and figure 4 shows a specimen in the second year. The primary root is still persisting, but the primary shoot (St.) has died down to the ground; the little leafy shoot (S), shown in the figure, is developed from the hypocotyl of the seedling. It bears two alternate, scale-like leaves, and two pairs of opposite with distinct, green blades; these green leaves are conduplicate, and although being opposite, they are not decussate, and they are of a very unequal size. The position of the leaves is thus very different from that of the foliage of the mature plant, but agrees with a number of species of the section *Anisophyllum*, in which, however, the leaf-blade is oblique. A member of this section *E. buxifolia* Lam. has been described by Warming, and some figures are given of mature specimens, showing the singular position of the leaves, opposite, but not decussate.

Young specimens of *E. Ipecacuanhae* in the third year (figure 5) show the persisting primary root (R), the scar

from the hypocotyl, a withered stem (St.) from the preceding year, and a shoot (S) with two alternate scale-like, and two opposite, green leaves of very unequal size, showing the same position as those of the younger specimen, described above. The beginning formation of a pseudo-rhizome may be seen from this figure (Fig. 5), where the basal internodes of the shoot from the preceding year have increased in thickness, and a bud, developed in the axil of a scale-like leaf, may develop into an aerial shoot in the course of a year or so. Large, mature specimens resemble this stage; the primary root persists, and all the aerial shoots proceed from the very short stem-portions close to the crown of the root, but none from the primary root itself.

When the plant reaches the flowering-stage, apparently in its fifth or sixth year, only one aerial shoot is developed, consisting of a subterranean axis of two to three very short internodes with scale-like leaves, of which the two uppermost subtend two aerial shoots, terminated by dichasia each with an apical, central cyathium. The cyathium of first order generally aborts, or fades away early. The green leaves of such spimens are opposite, but of very unequal size, both fertile, however. As regard the rhizome itself, this is vertical, and represented by a series of internodes with the scale-like leaves subtending small, ascending shoots of a pale, withish color, which are to develop into aerial shoots during the next season. This subterranean axis thus represents the base of an aerial shoot, and has become pulled down into the ground by means of the primary root being contractile. In large mature specimens numerous aerial shoots form dense clusters, depending on the profuse development of axillary shoots from the subterranean stem-portions, and some of these shoots may even ramify, while still buried deeply in the ground.

As mentioned above *Euphorbia Ipecacuanhae* has a flowering and a purely vegetative stage. Of these the latter may be generally observed in the latter part of June or in July, lasting until late in the fall, when all the stems die down to the ground. The leaves increase considerably in size, and the internodes in length. At this stage the branches of the second order have forked repeatedly, each bearing about seven vege-

PLATE XII.

tative shoots, the uppermost terminated by a small cyathium, which seldom develops any flowers. It is interesting to notice that the biennial *Euphorbia commutata* Engelm. shows a similar vegetative stage, but preceding the floral. In this species the seeds germinate during the summer, and the hibernating stage is fully developed in October. The seedling develops a system of relatively long, leafy shoots, the apical buds of which remain dormant throughout the winter. At this stage the leaves are long-petioled, obovate, and of a reddish color, while those of the flowering stage are green, roundish, and sessile. In the succeeding spring the foliage withers, and the stems bend down to the ground, though without rooting. The apical buds then grow out into erect shoots, terminated by inflorescences. It was this peculiar habit that induced Engelmann to name the species "*commutata.*"

Regarding the structure of the cyathium of *E. Ipecacuanhae* the glands of the involucre lack appendages, but the margin is very thin and of a greenish color; the apex of the involucral lobes is very distinctly fringed, thus reminding somewhat of the bracts, described above. Furthermore the minute stipules show a similar structure.

EUPHORBIA COROLLATA L.

In the section *Tithymalopsis,* to which the species belongs, only the uppermost stem-leaves are whorled or opposite; the leaf-blade is equal at the base, not oblique, and the cyathia are arranged in a large, umbelliform inflorescence. *Euphorbia corollata* is a tall perennial plant, the usually simple stem attaining a height of from four to ten dm. The leaves are scattered from the base of the stem to the whorl, subtending the rays of the inflorescences; of these the primary three to seven rays are again two- to five-forked. The cyathia are short-peduncled as compared with *E. Ipecacuanhae,* and the glands have large, white appendages (appearing like petals.) It is a habit strikingly different from that of *E. Ipecacuanhae,* but the deep root shows about the same form.

The composition of the inflorescence, or let us say, the arrangement of the cyathia, varies to a very great extent, and especially when lateral flower-bearing stems are developed

from the axils of the scattered leaves beneath the apical whorl of three to seven leaves, subtending the terminal inflorescence. Pleiochasia are common in this species; the primary five-rayed inflorescence may pass into trichasia of second, and dichasia of third order. The cyathium terminating the ray of first order frequently aborts; when developed, the peduncle is quite long, and much longer than those of the lateral rays. Monochasia occur also, notably in the uppermost rays. The simplest type of inflorescence may be observed in specimens, where the main, the primary axis has failed to develop, thus all the cymes are produced from the axils of the scattered leaves. It may be described as follows: Each of these lateral stems begins with a series of scattered leaves, up to eight, and becomes terminated by a whorl of three leaves. A lateral ray develops from the axil of each leaf, becoming terminated by a long-peduncled cyathium, while no cyathium is developed in the center of the primary whorl. These lateral rays have only one pair of leaves, subtending lateral rays of the same structure. We have thus a trichasium passing into dichasia of very regular composition. In specimens of that kind the rays of the inflorenscence do not bear any scattered leaves preceding the opposite. In normally developed specimens, however, the main stem may be the only one represented, and it is terminated by a whorl of leaves, most frequently four to five. These subtend four to five rays, none of which may be terminated by a long-peduncled cyathium; the cyathia appear first in the rays of second or third order, and are relatively short-peduncled; the originally four- to five-rayed inflorescence passes in such specimens into dichasia or even monochasia, which fork again in the same manner. Regarding the cyathia themselves they are in similarly rich-flowered specimens frequently purely staminate, mixed with a smaller number of androgynous.

Some large specimens with a whorl of six leaves, subtending six rays, showed the following ramification: one ray became terminated by a whorl of four leaves, the remaining five by a whorl of three; these rays of second order bore from one to two scattered leaves preceding the terminal whorls of three or four. Sometimes the habit of the species may resem-

ble that of *E. Ipecacuanhae,* branching already from near the root, but each shoot bearing many scattered leaves preceding the whorled. In such specimens the rays of various orders may be terminated by whorls of four to five leaves preceded by several scattered; these scattered leaves in the inflorescence subtend neither cyathia nor lateral rays.

The amply ramified inflorescence is thus characteristic of *E. corollata,* besides the occurrence of scattered, barren leaves in the inflorescence itself; such leaves were not observed in *E. Ipecacuanhae,* where all the leaves from the bifurcation upwards are normally opposite, very seldom in whorls of three. Moreover the stems and the leaves are frequently hairy from long, pointed, pluricellular (in one row) hairs. The cyathia contain frequently only staminate flowers; the bracts of these are hairy like those of *E. Ipecacuanhae,* but mostly simple, seldom bi-cleft; they contain laticiferous ducts, forming a dense net work, but no vessels were observed. The apex of the bracts is clavate, somewhat more slender than in the former species.

Euphorbia corollata has no purely vegetative stage succeeding the flowering; the stem above ground withers completely in the early fall, when the fruit has matured. We regret to say that we have, so far, never been able to detect the seedling-stage, and indeed none of the early stages of this species, although being frequent and abundant. Such is the case, however, of many other perenial herbs, while the annuals may be found at the seedling stage in large numbers.

EUPHORBIA MARILANDICA GREENE.

In typical *E. Marilandica* (Fig. 1) the appendages of the glands are quite broad (Fig. 7) and white, thus the cyathia resemble those of *E. corollata,* but are much smaller. A peculiar form with the appendages white, but much narrower, occurs in this vicinity, and may be named forma *albo-marginata* (Fig. 8); they are strikingly different in habit, however. Of these the typical is identical with *E. arundelana* Bartlett.

The earliest flowering specimens of typical *E. Marilandica* were collected in the latter part of May, in gravelly soil, in open thickets of *Sassafras.* The height of the erect aerial

stem is about 30 cm.; the first six leaves are scattered, gradually increasing in size from the base upwards. Then follows a whorl of three leaves of almost equal size, and larger than the scattered, surrounding a long-peduncled cyathium, terminating the stem,and subtending three rays with long internodes; two of these rays are terminated by a cyathium and two opposite leaves, while the third bears a whorl of three leaves, subtending a trichasium with central, terminal cyathia. In other words the main stem resembles that of *E. corollata* with the several leaves scattered, and terminated by a whorl of three leaves, subtending three rays, passing into trichasia or dichasia; all the cyathia are long-peduncled, however, but the foliage as well as the stem are hairy. Only one of the cyathia of first order, and two of second order contained a pistillate flower. In specimens from the same locality, but collected in June (Fig. 2) the stem averages a height of about 35 cm., and branches from almost the base, like *E. Ipecacuanhae,* besides that the stems and leaves are perfectly glabrous. These specimens bore very small, opposite leaves, almost scale-like, at the base of the three primary rays, while the succeeding were large, green, in whorls of three on the two branches, but opposite on the third one. The ramification continued as mono- or dichasia, the former being the prevalent. In a specimen growing in sandy soil at the border of a cleared woodland, where *E. Ipecacuanhae* occurred in great abundance, three flowering stems, all from the same root, were examined during the months of June and August. The stem collected in June (18th.) measured 39 cm. in height, and was branched from close to the soil, but the main stem had not developed. Two shoots had developed from the base of the main stem, and they were not opposite. They were of a very different length, the basal only half as long as the upper, but both showed a series of four to five scattered leaves, preceding a whorl of five, much longer, and each subtending a lateral ray. A central cyathium, long-peduncled, was only observed on the lower stem. But common to both stems were the regular succession of dichasia with central cyathia, some of which had developed young fruits. This stem thus showed a series of scattered,

barren leaves preceding a pleiochasium (5 rays), passing into dichasia.

Another stem, collected early in August, showed an erect stem, 16 cm. in height, bearing four scattered leaves, two of which subtended small vegetative shoots, and preceding a whorl of three very large leaves, subtending a trichasium. One of the rays of the trichasium, however, passed into monochasia, while the two others began with dichasia passing into monochasia at the apex. Several immature fruits were observed upon this stem. We have thus in this stem, from the same root as the preceding, an approach to the habit of *E. corollata,* the stem being leafy, erect, and tall before the inflorescence begins.

A third stem, collected late in August, measured about 20 cm. in length, but was profusely branched in the apical part of the rays. Two forks were developed close to the ground, each with a single leaf preceding the fork of second order, and these secondary forks began as trichasia passing into numerous dichasia, the apical with a foliage consisting of very small, narrow bracts; the cyathia had dropped. One to several scattered leaves were thus preceding the inflorescence in these three stems; the primary inflorescences were developed from whorls of three to five large leaves, and they passed into mono- or dichasia; the main stem was long or very short.

When we removed the third stem, no others were left, and much to our surprise a fourth shoot developed very soon after and bloomed in the middle of September. It was rather low, and both stems and leaves were hairy as in *E. corollata;* being forked close to the surface of the soil the habit, however, reminded of *E. Ipecacuanhae.* The main stem was five cm. in height terminated by a long-peduncled cyathium with a large, but immature fruit, and two opposite leaves of small size, subtending two rays. Each of these rays was terminated by a cyathium and a whorl of three large leaves subtending trichasia, passing into dichasia. Beneath this terminal inflorescence, three shoots had developed from the basal, mostly opposite, leaves of the stem. One of these three shoots was terminated by a long-peduncled cyathium with two opposite leaves, subtending two rays bearing three to five scattered

leaves preceding a whorl of three leaves, large, but of unequal size, and subtending only two lateral rays with dichasia. The two other shoots began directly with a series of scattered leaves (mostly four) preceding a trichasium with a central cyathium; the apical inflorescences were, also, in these dichasia. Thus in the inflorescence itself this late developed shoot showed some of the characteristics of *E. Ipecacuanhae* and some others of *E. corollata*, all united upon one single shoot with hairy stem and leaves, and developed from the same root as the three stems described above.

The cyathia of typical *Euphorbia Marilandica* contain most often only staminate flowers with the bracts simple, seldom bicleft.

EUPHORBIA MARILANDICA FORMA *ALBO-MARGINATA*.

We found this form in the first week of June, growing in sandy soil, in a cleared woodland (Pinus), associated with *E. Ipecacuanhae* and typical *E. Marilandica*. About twenty stems were developed from one root, and their length averaged about 30 cm.; they were ascending, and several of the basal cyathia bore matured fruits (Fig. 3) with germinative seeds of the same structure as those of *E. Ipecacuanhae*. All the stems showed the same type of inflorescence: forking close to the surface of the soil with the first pair of opposite leaves much smaller than the succeeding (as in *E. Ipecacuanhae*), subtending dichasia with central, long-peduncled cyathia, and with the ultimate rays passing into monochasia, or repeating the first type, dichasia; all the internodes were considerably longer than in the typical plant, and the cyathia, especially the basal, long-peduncled. As mentioned above the appendages of the glands are white but much narrower than in the typical plant (Fig. 8); the bracts of the staminate flowers are broader and much more hairy than those of the typical plant; they are mostly entire, seldom three-cleft; ducts as in *E. Ipecacuanhae*, but no vessels were observed. The pistillate flower was well developed in most of the cyathia.

But neither the typical plant nor the forma *albo-marginata*

have any purely vegetative stage succeeding the flowering; the stems and the foliage wither during the early fall.

In comparing the large material which we had collected of these plants the structure of the inflorescence, or to be more correct the arrangement of the cyathia varied only so far as concerns the number of rays. The cyathia themselves exhibited a marked difference with regard to the relative length of the peduncle; the development or non-development of appendages to the glands; the width of these appendages, and finally the structure of the bracts of the staminate flowers. The foliage showed also some certain modifications as to the size of the leaves subtending the rays; the presence or absence of scattered leaves upon the shoots or upon the rays, preceding the forks of first or second order as in the late blooming specimen of *E. Marilandica.* Taking these points into consideration, the results of the comparison may be summarized as follows:

Euphorbia corollata: pleiochasia are frequent; the primary three- to seven-rayed umbel passes into pleio- or trichasia followed by dichasia, seldom by monochasia. Scattered leaves, glabrous or hairy, precede the whorled, which subtend the rays of first order, and sometimes also those, which subtend the secondary rays. Cyathia relatively short-peduncled, except sometimes the basal, those of first order. Appendages of the glands large, white. Bracts of the staminate flowers mostly simple and slender, seldom bicleft, densely covered with long hairs, and containing laticiferous ducts, but no vessels. The tall stem and foliage often hairy from long, pointed, pluri-cellular hairs (one row.)

E. Ipecacuanhae: trichasia are rare: dichasia much more frequent than monochasia. Cyathia long-peduncled. Glands destitute of appendages. Bracts of the staminate flowers frequently laciniate (five-cleft), seldom simple, densely covered with long hairs, and containing ducts as well as tracheae. The short stem, and foliage glabrous, no scattered leaves in the inflorenscence, seldom at the base of the main stem.

Typical *E. Marilandica*: Trichasia as well as pleiochasia (5 rays) not uncommon, passing into mono- or dichasia, the latter being the most frequent. Cyathia long-peduncled.

Glands with broad white appendages. Bracts of the staminate flowers simple, seldom bicleft, much less hairy than in the former two species, containing ducts, but no vessels. Stem more or less developed, mostly glabrous like the foliage, or hairy in the earliest and latest blooming specimens. Scattered leaves occur sometimes upon the rays themselves.

Forma *albo-marginata*: Dichasia the most frequent, passing, sometimes, into monochasia. Cyathia long-peduncled. Glands with white, narrow appendages. Bracts of the staminate flowers broader and more hairy than in the typical plant, mostly simple, seldom three-cleft; ducts as in *E. Ipecacuanhae*, but no tracheae. Stem short, glabrous like the foliage. No scattered leaves were observed.

To these structural differences may be added, that no fully developed fruits were found in typical *E. Marilandica*, and the pistillate flower was absent from many of the cyathia. In the forma *albo-marginata*, on the other hand, the pistillate flower was well represented; mature fruits with germinative seeds, of the same structure as those of *E. Ipecacuanhae* were found in several specimens. This particular form thus constitutes a transition from *E. Ipecacuanhae* to typical *E. Marilandica;* in habit it simulates *E. Ipecacuanhae*, but the white appendages indicate an approach to typical *E. Marilandica*, besides to *E. corollata*. Typical *E. Marilandica* is sterile, so far as we know; the habit fluctuates between that of *E. corollata* and *E. Ipecacuanhae;* the appendages resemble those of *E. corollata*, but the cyathia are constantly long-peduncled as in *E. Ipecacuanhae*. The stem and foliage is sometimes hairy as in *E. corollata*. Two characters of importance are possessed by *E. Ipecacuanhae* alone: the bracts of the staminate flowers containing vessels, and the plant exhibiting a well marked vegetative stage succeeding the flowering; during this vegetative stage the internodes increase considerably in length, as well as the leaves in length and width, persisting until very late in the fall, thus remaining active for a much longer period than the axis and foliage of *E. corollata* and *E. Marilandica*. In this particular respect *E. Ipecacuanhae* simulates *E. commutata*, a biennial species of very remote relationship, but with a hibernating, vegetative stage preceding the flowering.

INTERNAL STRUCTURE OF THE VEGETATIVE ORGANS.

THE LEAF.

Euphorbia Ipecacuanhae: Structure unifacial, the stomata being distributed over both faces of the blade, and the chlorenchyma consisting of a palisade tissue on both faces, enclosing a more open pneumatic tissue of roundish or oblong cells. Lateral cell-walls of epidermis almost straight. Laticiferous ducts abound in the chlorenchyma, frequently extending to the epidermis, forming a dense net-work beneath this. Midrib with a large water-storage-tissue on both faces, surrounding the mestome-strands, five in the lower half of the leaf, but only a single above; stereome very thin-walled, forming an arch outside the leptome. No collenchyma was observed.

E. corollata: Lateral cell-walls of epidermis prominently undulate, especially on the dorsal face of the blade. Pluricellular, pointed hairs abound, especially on the lower face, but not in all specimens. Midrib with hypodermal collenchyma on the dorsal face; collenchyma occurs also in the margin of the blade. Otherwise the structure is identical with that of *E. Ipecacuanhae*.

E. Marilandica and forma *albo-marginata*: Lateral cell-walls of the epidermis slightly undulate on both faces; pluricellular, pointed hairs as in *E. corollata*, but not in all specimens. Structure otherwise as in *E. Ipecacuanhae*.

The foliar structure of *E. Marilandica* thus shows some features in common with *E. corollata*: the undulate, lateral cell-walls of the epidermis, besides the occasional development of hairs, but otherwise the structure agrees better with that of *E. Ipecacuanhae*. Regarding the structure of the internodes the habit of these species is so different, that none of the internodes are actually comparable. When we finally append a brief comparison between the structure of the peduncle, which bears the cyathium, and the axis of the fruit, this is for the purpose of defining, whether this axis simply represents a gynophore or a real peduncle.

E. Ipecacuanhae: Peduncle of the cyathium compressed,

glabrous; cuticle thick, smooth; outer cell-wall of the epidermis moderately thickened; hypodermal stratum of cortex slightly collenchymatic; the inner three strata of round cells, filled with chlorophyll; the innermost five to six strata with very little chlorophyll, traversed by laticiferous ducts, and several cells contain raphides. There is no endodermis, but a closed sheath of three to four layers of thin-walled stereome. Stele of about ten mestome-strands with a few layers of interfascicular cambium and libriform. Ducts numerous in the stereome. Pith compressed, containing a little starch and ducts, solid, not hollow. Axis of a large fruit: cylindric; cuticle, epidermis and hypodermal cortex as above; cortex of six strata of roundish cells, containing chlorophyll; stereome as above; stele of six mestome-strands, three broad strands alternating with three narrower. Pith as above.

E. Marilandica forma *albo-marginata*: Peduncle of the cyathium cylindric; stereomatic sheath thicker than in the former species, structure otherwise the same. Axis of a large fruit shows the same structure as in *E. Ipecacuanhae.*

Typical *E. Marilandica*: Peduncle of the cyathium almost cylindric, very slightly compressed; epidermis and hypodermal collenchyma as in *E. Ipecacuanhae;* cortex of only six strata with laticiferous ducts; stereome as more or less isolated strands of two to three layers covering the leptome of the ten mestome-strands; libriform as a continuous sheath through the stele; ducts numerous in the stereome; pith very narrow. Axis of a small fruit as in *E. Ipecacuanhae.*

E. corollata: Peduncle of the cyathium cylindric; cuticle very thick, and outer cell-wall of epidermis much thicker than in any of the other species; cortex of three to four peripheral collenchymatic, and three to four inner strata containing chlorophyll; stereome as isolated strands with many ducts covering the leptome of the twelve mestome-strands, representing two sizes, alternating with each other; libriform as a continuous sheath; pith solid, not hollow. Axis of a large fruit: cylindric, cuticle and epidermis as in the peduncle of the cyathium; hypodermal stratum of cortex collenchymatic, the inner five to six strata containing chlorophyll; stereome as isolated arches of one to two strata covering the leptome of

the twelve mestome-strands, which show the same structure as in the peduncle of the cyathium; ducts numerous in cortex and stereome; pith solid.

The structure of the peduncle of the cyathium and of the axis of the fruit is thus very uniform in these species, but some deviations do occur, by which *E. corollata* may be readily distinguished from the others. *Euphorbia Marilandica* agrees much better with *E. Ipecacuanhae* so far as concerns the internal structure. Considering the structure of the axis of the fruit, this is in all respects so similar to the structure of the peduncle of the cyathium, that it must also be regarded as a "peduncle" from an anatomical point of view. We have seen no other modifications than the cortical parenchyma being a little broader in the peduncle of the cyathium. All the tissues show identically the same arrangement in both peduncles.

In some of the *Caryophyllaceae,* for instance in *Silene,* the corolla, stamens and ovary are raised above the calyx, upon a lengthened internode "gynophore," and in certain species of *Gentiana* the capsule is stipitate. We have examined the structure of the gynophore in *Silene dichotoma* Ehrh., and the stipe in *Gentiana Andrewsii,* and compared the structure with that of the stem in these species, in order to find out how far the various tissues might become modified. In *Silene* a young lateral branch of the inflorescence shows the following structure: Cuticle thick smooth; outer cell-wall of epidermis thick; cortex of three compact strata with chlorophyll surrounding a broad zone of typical collenchyma in about ten strata, bordering directly upon the leptome of the four mestome-strands. There is no interfascicular cambium, the pith extending to the collenchyma. Pith very broad. In the gynophore the cuticle and epidermis show the same structure as in the stem, but the cortex shows the cells of the seven layers arranged very regularly in radii, and there is no collenchyma; moreover the stele is triangular in cross-sections, and contains six mestome-strands, three larger alternating with three much thinner; pith narrow. Characteristic of the structure of the gynophore is thus the radial arrangement of the cells in the cortex, the absence of collenchyma, and the triangular stele.

In *Gentiana* the internodes of the inflorescence are cylindric; cuticle thick, but smooth; outer cell-wall of epidermis very thick, and showing many layers; hypodermal stratum of cortex slightly collenchymatic, the inner six to seven strata with relatively wide intercellular spaces. There is no endodermis and no stereomatic pericycle, but a closed sheath of thin-walled collenchyma in two layers surrounds the cylindric stele of a compact mass of bicollateral mestome-strands; pith thin-walled, of ordinary parenchymatic structure. In the stipe the outline is pentagonal; the cuticle is thin, and the epidermis thin-walled. Viewed in cross-sections the cells of the epidermis and of the adjoining two strata of the cortex show the shape of typical palisade-cells, while the inner part of the cortex is of ordinary parenchyma cells in about eight strata, bordering on the pentagonal stele of five thick mestome-strands alternating with three much thinner, making a total of twenty strands; the pith shows a very peculiar structure, the cells being long (in cross-sections), slightly branched, and forming an open network. Characteristic of the stipe is thus the palisade-structure of the epidermis and the peripheral cortex, the absence of collenchyma, and the peculiar, very open parenchyma of the pith. In other words there is a well marked difference between the structure of the gynophore and the stipe on the one side, and the stem on the other, in no wise comparable to the slight modifications in structure, observed in the peduncles of cyathium and fruit of *Euphorbia*.

SUMMARY.

Typical *Euphorbia Marilandica* was seldom observed to develop fruits, and the seeds were not germinative. The habit and the white appendages of the glands agree sometimes better with *E. corollata*, than with *E. Ipecacuanhae* besides that the stem and foliage are sometimes hairy; the internal structure, on the other hand, reminds more of *E. Ipecacuanhae*. The forma *albo-marginata* makes an approach to *E. corollata* by the narrow, white appendages, but the habit is that of *E. Ipecacuanhae*. We feel inclined to believe that *E. Marilandica* represents a hybrid between *E. corollata* and *E. Ipecacuanhae*, even if the time of flowering is so very different, the former blooming much later than the latter. But as stated above *E. Marilandica* grows especially in or near cleared woodlands, and is always associated with *E. Ipecacuanhae*. Some few years ago we had the opportunity to see the very first vegetation that appeared after the clearing of some woodland (mostly *Pinus*) near Clinton. There were many specimens of *E. Ipecacuanhae*, and they were in full bloom as late as July, thus cross-fertilization with *E. corollata* might readily be effected. No doubt *E. Ipecacuanhae* had persisted in the soil, in a dormant stage, for the rhizomes were as deep as 26 cm. beneath the surface. Similar instances we have observed before, notably in plants multiplying by root-shoots, *Chamaenerium angustifolium*, *Convolvulus spithamaeus*, etc.

Regarding the morphological interpretation of the cyathium in *Euphorbia* as defined by Robert Brown, but indicated already by Lamarck and de Jussieu, and more fully elaborated by Roeper, Wydler and Warming, this interpretation has been generally accepted in spite of the objections raised by Payer, Baillon and R. Pedersen. According to the last author, the main point depends upon whether the cyathium contains only one or several axes; in the former case it would represent a flower, in the latter, as defined by Robert Brown, an inflorescence. When Pedersen insisted that it had never been proved, that it contains more than one axis, he based this opinion upon the actual fact that no direct proof had been offered, so far, to the effect that the small, hyaline scales in the cyathium were true leaves "bracts." We have shown in the preceding pages that these organs contain vessels and laticiferous ducts, thus their foliar nature can not very well be disputed. Strange to say, Roeper must have seen the tracheae, for in his Enumeratio p. 39, where he describes the "folia, bracteae auct," he writes: "Semper fere enervia sunt;" he must have seen some, for otherwise he would not have written "fere." Thus so far as concerns the staminate flowers they are more or less distinctly subtended by real bracts, and concerning the peduncle, which bears the female flower, this shows the typical, anatomical structure of an axis, when compared with the peduncle of the cyathium. Consequently the cyathium represents an inflorescence, one of the most complicated known, and composed of the very simplest type of flowers.

BIBLIOGRAPHY.

Brown, Robert. General remarks, geographical and systematical on the botany of Terra Australis. Reprinted from a voyage to Terra Australis, by Matthew Flinders London 1814. (Miscell. Bot. works of Robert Brown. Vol. London 1866, p. 28.)

Brown, Robert. Observations on the natural family of plants called *Compositae* (Transacts. Linn. Society of London Vol. 12. London 1817, p. 99.)

Greene, E. L. Pittonia III. 1896-1898, p. 345.

Jussieu, A. L. de. Genera plantarum secundum ordines naturales disposita. Paris 1789, p. 386.

Jussieu, Adrian de. Considérations sur la famille des Euphorbiacées Mém. du Mus. Vol. 10, 1823, p. 317.

Lamarck, J. B. Encyclopédie methodique Botanique. Vol. II. Paris 1786, p. 413.

Lamarck et De Candolle. Flore Française. Vol. III, Paris 1805, p. 329.

Linnaeus, C. Genera plantarum. Ed secunda. Leyden 1742. p. 237.

Pax, F. Allgemeine Morphologie der Pflanzen. Stuttgart 1890. p. 150.

Pedersen, R. Koppens Udvikling hos Vortemaelken. Botan. Tidsskr. Series 2. Vol III. Kjoebenhavn 1873-1874. p. 97.

Roeper, Johannes. Enumeratio Euphorbiarum quae in Germania et Pannonia gignuntur. Goettingen 1824.

Roeper, Johannes. Vorgefasste Botanische Meinungen. Rostock 1860. p. 35.

Schumann, K. Neue Untersuchungen ueber den Blüthenanschluss. Leipzig 1890. p. 288.

Ventenat, E. P. Tableau du règne végétal selon la méthode de Jussieu. Vol III. Paris 1799.

Warming, Eug. Er Koppen hos Vortemaelken (*Euphorbia L.*) en Blomst eller en Blomsterstand? Thesis Kjoebenhavn 1871.

Warming, Eug. Forgrenings-Forhold hos Fanerogamerne. Avec un résumé en français. Vidensk. Selsk. Skr. Series 5, Vol. 10, I. Kjoebenhavn 1872.

Warming, Eug. Recherches et remarques sur les Cycadées. Oversigt. Kgl. Danske Vid. Selsk. Forhdlgr. Kjoebenhavn. 1877. p. 88.

Warming, Eug. Disposition des feuilles de *l'Euphorbia buxifolia* Lam. Bull. de l'Acad. R. d. sc. de Danemark. Copenhague 1896. p. 1.

Warming, Eug. Froeplanterne (Spermatofyter.) Kjoebenhavn 1912. p. 286.

EXPLANATION OF PLATES.

PLATE 1.

Figure 1. *Euphorbia Marilandica* Greene; natural size.

Figure 2. Same species; natural size.

Figure 3. Same species forma *albo-marginata;* a cyathium with mature fruit, enlarged.

Figure 4. *Euphorbia Ipecacuanhae* L.; young plant in its second year; S—leafy shoot with two pairs of opposite, conduplicate leaves; St—the withered hypocotyl; R—the primary root; natural size.

PLATE 2.

Figure 5. *Euphorbia Ipecacuanhae* L.; young plant in its third year; S—leafy shoot; St.—withered stem from the preceding year; R—the primary root; X 2.

Figure 6. Same species; a cyathium; enlarged.

Figure 7. *E. Marilandica;* gland with appendage; enlarged.

Figure 8. Same species forma *albo-marginata;* gland with appendage; enlarged.

Figure 9. *E. corollata* L.; gland with appendage; enlarged. (Figures 7-9 are drawn in the same scale.)

Figure 10. *E. Ipecacuanhae;* bract with five laciniae from the male inflorescence; X 90.

Figure 11. Same species; one of the thin, entire bracts from the male inflorescence; X 90.

Figure 12. Part of the bract (fig. 10) showing laticiferous ducts; X 112.

Figure 13. Apex of same bract showing two spiral vessels; X360.

The Story of the Diamond.

H. D. CRIDER, *University of Kentucky.*

Man becomes a very complex organism when we attempt to analyze his different qualities, but, after all, he is only the sum total of these several qualities. One of the inherent traits of the human is the love of the beautiful. This love is often dormant and is even apparently lacking in some people, but is generally brought to light in everyone in little insignificant acts which pass almost unnoticed. This quality is a hereditary one which was gradually developed during those ages of antiquity while our forefathers were developing the other human traits which are common to man today.

During those hazy ages of the past, this love for the beautiful in our ancestors was naturally limited to admiration of the concrete aspects of nature which surrounded them. Sculpture and art were not yet developed. The majestic hills, the trees, the birds, and the shimmering sheets of water comprised the art of the pre-historic man.

Among the things which excited the fancy and speculation of these first men were the glittering and brightly colored stones which they found in the gravel and sands of river beds. Few of the things of nature surrounding him could inspire a feeling of awe and wonder like these little bits of stone. The ecstacy of a modern lady when she beholds the glittering creation on her finger is but an outgrowth of this primitive instinct. We can but speculate on the feelings of the wild savage who picked up for the first time the sparkling stone from the sand at his hut door, and the time of this important event cannot even be estimated, but the very fact that the earliest historical man valued them highly proves that this event dates back far into the gloomy ages of antiquity.

India, the land where one of the oldest civilizations developed, holds the honor of producing the first authentic diamonds. India was, therefore, regarded as the natural home of the diamond. Traditions of this land are replete in diamond lore, and these date back to the time before the exploits of Achilles, before Troy.

The name "diamond" comes from the Greek word "adamas" which means "the unconquerable." This name was probably applied to the stone because of its great resistant power. The change of "adamas" into the word "diamond" is thought to have come from prefixing to it the Italian word "diafano." Garcia de Orta, a Portuguese physician employed by the viceroy of Goa, was the first to describe diamonds.

Eight localities of India are shown by tradition or authentic reports to have produced diamonds. These are Harma (Himalayas), Kistna and Godavari (Golconda), Saurashta (Surat), Paunda (including the Chutia Nagpur province), Kalinga (between the Orissa and the Godavari rivers), Kosala (modern Berar), Vera Ganga (the Wemganga,) and Saubira (between the Sarhund and Indus rivers).

Along the banks of the Kistna and Godavari rivers is the Golconda of tradition. Golconda, or the kingdom of Golconda, was a loose term applied by foreigners and travelers to this general region of which Golconda was the capital. This territory early came under the control of the Nizam of Hyderabad and was included in the Madras Presidency. It was the richest diamond field of India and it is a reputed source of the famous Koh-i-noor, Regent, and Great Mogul diamonds. Jean Baptiste Travernier, a French gem merchant, visited the Golconda between 1638 and 1665. He says shallow pits were sunk and the gravel was excavated and crushed in walled inclosures. Water was then poured over the crushed rock, after which it was sifted in baskets and sorted by hand. Buying and selling was conducted at this period by young children. Sporadic mining was carried on here for centuries. Travernier found sixty thousand workers in 1665 in the Gani-Coulour mine which had already been worked for one hundred years. This mine has probably been identified with the modern Kolur mine on the Kistna river, "Gani" being simply a slight change of the Persian word "Kani" or "mine of."

Next in importance to the mines of Golconda was the diamond field of Sambulpur between the Mahauadi and Brahmini rivers. Here the stones were found chiefly along the course of the Mahouadi in a stratum of tough clay and pebbles stained reddish by iron oxide. The diamonds were remark-

able for their purity and beauty, although no very large crystals have been found here. During the dry season thousands of villages including men, women and children, made the search for diamonds. The men dug the diamond-bearing ground from the river banks with picks, and the women separated the diamonds from the clay with "dears." These "dears" were shovel shaped boards, about five feet long, with ridged sides and a hollow center. After slightly tilting it, water was poured in on one side and allowed to wash away the clay and coarse gravel, leaving the gold and diamonds to be picked by hand from the fine gravel. This field was the most ancient in India, but was not worked after 1850.

At Panna the diamond-bearing conglomerate was buried under a cover of heavy ground, sometimes thirty feet thick, necessitating laborious digging. To reach the diamond strata large pits were dug, and, as there was no drainage, the laborers were sometimes forced to work in water knee deep during the rainy season. The conglomerate was broken up and hauled to the top of the pit by hand, after which it was picked for diamonds. The stones of Panna are graded into four divisions: (1) the clear and brilliant stones are called "Motichul;" (2) those of greenish cast are called "Mansk;" (3) those yellow are called "Panna;" (4) those sepia colored are called "Bunsput."

With the expansion of Greek trade the precious stones of the Orient began to pass into Europe. Herodotus, 484 B. C., was the first of the early Greek writers to mark the displays of precious stones in the palaces and temples of Eastern kings. He mentions the signet rings of Darius and Polycrates and the emerald column in the Temple of Hercules in Tyre. Thus the riches of the Orient gradually became known to Europeans. The conquests of Alexander the Great acquainted the Greeks with the precious stones of India as well as those of Persia and Turkey. Alexander's successors long retained possession of many of the most valuable spoils of his conquests, among which are many precious stones.

With the spread of the Roman Empire the spoils of the whole Eastern world flowed into the city of Rome. Especially after the victory of Pompeii over Mithratates was there a pro-

fusion of precious stones in the city. Pliny wrote thus: "We drink out of a mass of gems crusting our wine bowls, and our drinking cups are emeralds."

Gems began to be used for studding the mountings of pictures, and for the ornamentation of statuary, and for the decoration of arms and trappings, as well as for personal adornment. During all this time not much is said of the diamond. The uncut diamond is not so attractive a stone as were many others then known. It is supposed that the extreme hardness of the stone prevented its extensive use. There was no scientific cutting of facets in diamonds to improve brilliancy until the fifteenth century, and even then the proportioning was so poor that much of their latent brilliancy was left undeveloped. The Indian lapidaries cut stones in this unscientific manner and it was not until 1465 when Louis de Berguem of Bruges re-cut the Beau Sancy that the art of modern cutting began. With the improved cutting method the demand for diamonds grew enormously and prospectors penetrated every remote locality in search of diamond-bearing soil.

The Brazilian diamond fields were discovered in 1729. The diamonds were first found in river sands which were being washed for gold, but the gold miners did not attach much importance to the glittering crystals. A monk who had seen Indian diamond mines was the first to recognize them as diamonds. Immediately after the discovery of the fields the king of Portugal took possession of all of them.

These river sands, while still important diamond producers, have given place to upland deposits. The origin of these stones is not well understood. They do not appear to have originated in eruptive rocks. They were formerly thought to be constituents of a quartz shist, but are now thought by Orville A. Derby, late Director of Geological Commission of Brazil, to be formed from the carbon in phyllites of the region by intrusion into them of pegmatite dikes.

In 1851 the first discovery of diamonds in Australia was made in alluvial deposits near Bathhurst. They have since been found at Mudgen, Bingara, and Inverell in New South Wales. In 1905 a stone weighing 29 carats was found near

Mount Merong. They have also been found at Eschunga in South Australia; Beechworth, Arena, and Melbourne in Victoria; Freemantle and Nullagine in West Australia; and in the Palmer and Gilbert rivers in Queensland. All have been small stones. A few diamonds have been found in the Corinna gold fields of Tasmania.

The first discovery of diamonds in South Africa was made in 1867 by Dr. W. E. Atherstone, who called a stone found by a child on the banks of the Orange river a diamond. It was bought for $500 and displayed in the Paris Exhibition of that year. In 1869 a stone weighing 83 carats was found near Orange river, was purchased by the Earl of Dudley for $2500 and became the famous "Star of South Africa." A rush of prospectors followed and considerable discoveries resulted in the river gravel of the Orange and Vaal rivers. By 1870 a mining camp of 10,000 persons was formed in this region. A digger's committee limited the size of claims to 30 square feet. Toward the close of 1870 stones were found at Jagersfontein and at Dutoitspan and led to a second rush of prospectors. In 1871 the Kimberly mine was opened near Dutoitspan. This mine was at first a series of mines or pits having a diameter of 31 feet each. It was later found that each mine was a huge vertical crater descending to an unknown depth. Roadways across the pits fell in and a gigantic system of cables and windlasses was installed, and the mine was made into one big pit. Steam winches were installed in 1875 to hoist the blue ground. But open pit mining soon became dangerous due to landslides and mud rushes, and by 1883 when the Kimberley had reached a depth of 400 feet mining became impossible. By 1889 mining in all the large mines was conducted by means of tunnels and shafts. Cecil Rhodes and Alfred Beit obtained control of the Kimberley in 1889, and they already controlled the DeBeers mine. They developed their property according to the most modern methods.

Many searches had been made for diamonds in the Ural Mountains and they were finally found in 1829 in the gold washings of Bisserek and later at Ekaterinburg. In Lapland they have been found in the sands of the Pasevig river.

Siberia has yielded isolated diamonds from the gold washings of the Yenisei river.

In the United States a few small stones have been found in alluvial deposits, mostly auriferous, in Georgia, N. Carolina, S. Carolina, Kentucky, Virginia, Tennesee, Wisconsin, California, Oregon and Indiana. A crystal weighing 23 1-4 carats was found in Virginia in 1886. In 1906 a number of small diamonds were found in altered peridotite in Pike County, Arkansas. In 1855 a crystal weighing 21 1-2 carats was found in Wisconsin. Kentucky and New York have rocks similar to the blue ground of South Africa but as yet have yielded no diamonds. Many believe that diamonds found in Wisconsin, Michigan and Ohio in terminal moraines indicate a Canadian origin.

In California stones have been found since 1859. The record follows:

In 1859 John Bradshaw found a small white stone in the Buchanan Mine at Smith's Flat.

In 1865 John Lyford found a white stone weighing .97 carats at Smith's Flat.

In 1867 Ward Brothers found three small stones near White Rock Canyon, the largest of which was worth $50.

In 1868 T. Ward & Co. secured three stones at Live Oak mine, Reservoir Hill, two of which were white and one yellow.

In 1868 T. Potts found near White Rock Canyon a light yellow stone weighing .65 carats.

In 1868 Mrs. S. Henderson found a white stone in Wisconsin Flat mine.

In 1868 Cruson and Olmstead found four stones in Wisconsin Flat mine.

In 1869 H. Olmstead found a stone worth $280, weighing 1.82 carats.

In 1870 McConnel and Reed found a canary colored stone east of Texas Hill.

In 1870 N. O. Ames found a stone weighing 1.3 carats in a mine on Weber Hill.

In 1870 Charles W. Schafer found a stone weighing .81 carats in the Tolkey mine, Texas Hill.

In 1878 F. Bendfeldt found a canary colored stone weighing .45 carats at Smith Flat.

In 1879 E. Randall found a white stone in the Wisconsin Flat mine.

In 1896 Bert Carpender found 2 white stones, weighing 1.96 and .26 carats and a white stone weighing 1.67 carats.

In 1897 Snow Bros. found a canary colored stone weighing .97 carats near Fairplay.

In 1899 Bert Carpender found a white stone weighing .65 carats in the Stanley mine, Smith's Flat.

In 1900 F. Bosworth found a white stone weighing 1.46 in Cedar Ravine, Placersville.

In 1901 J. Allen found a white stone weighing .42 carats in Cedar Ravine, Placersville.

In 1912 Bert Carpender found a white stone weighing .97 carats in the Carpender mine, Prospect Flat.

Many superstitions are connected with the diamond. Prehistoric man was, of necessity, religious and superstitious because he lived so close to the mysteries of nature. Many of these superstitions still persist. One of the most interesting legends concerning diamonds preserved today is that of Sinbad the Sailor in the Valley of Diamonds. Sinbad was stranded by shipwreck on a desert island and was carried away by the flight of a large "Rukh" to a distant mountain. From this mountain he descended into a deep valley whose soil was composed of diamonds. He describes these stones as ones on which neither iron nor hardhead had effect and from which a piece could not be cut off.

Much speculation was indulged in to explain the origin of diamonds. Ancient people thought they were splinters from stars or creations of genuii. Some Hindu miners still believe that diamonds grow like onions, and that a new crop appears every twenty or forty years. Some attributed the formation of the stones to the hardening of dewdrops.

According to classical mythology, the diamond was first formed by Jupiter who turned into stone a man known as Diamond of Crete for refusing to forget him after ordered to do so.

Diamonds have been considered valuable from a medical

standpoint as antidotes for poison and the prevention of mania. They are also supposed to act as a peacemaker between husband and wife.

Most of the older diamonds have histories and legends connected with them which exceeds the wildest flights of fancy. In the days before modern production made diamonds common, a diamond was a treasure worth almost any price, and many human lives were sacrificed to satisfy the avarice of rulers of former times.

Many of the famous large diamonds of the world have come from India, and their origin is usually traceable to the period between the thirteenth and eighteenth centuries. Some of the best known of these are the Koh-i-noor, Pitt, Orloff, Great Mogul, Florentine, and the Beau Sancy.

The Koh-i-noor was long held as an heirloom in the family of the Rajah of Malwa, who in 1304 sold it to the Sultan Alaeddin. It was later given by the Sultan to the Rajah of Gwalior, but when this official was defeated by Humairen, Emperor of Hindustan, the latter obtained possession of the diamond. It stayed in possession of the Mogul Dynasty until obtained by the Persian conqueror Nadir Shah in 1739, who exclaimed, "Koh-i-nur," which means "Mountain of Light" when he saw it, thus giving it its name. In 1751 after the assassination of Nadir Shah it was given by his son to Ahmed Shah, the founder of the Afghan Empire. An Indian prince, Runjit Singh, later obtained the diamond by conquest and brought it to Lahore and presented it to the shrine of Juggernaut where it remained until sent to Queen Victoria of England in 1850 by messengers of Lord Dalhousie. At that time it weighed 186.1-16 carats, but was recut in 1852 by Messrs. Coster of Amsterdam to 106 carats. Its quality is not the best for it has a slight grayish tinge.

The Regent, or Pitt Diamond, was found in India in 1701 by a slave who concealed it in a wound in his leg. He thus got it safely to the coast where he gave it to an English skipper in return for passage to a free country. The skipper threw the slave overboard, sold the diamond to a gem merchant for $5,000, squadered the money, and hung himself. Sir Thomas Pitt, governor of Ft. St. George at Madras, pur-

chased the stone from a merchant for $120,000 and took it to England. While in London it was cut into the form of a brilliant, the operation reducing it from 410 to 136 3-4 carats. After living in disguise to prevent its being stolen, Sir Thomas sold it to the Duke of Orleans in 1717. The stone remained in the French crown jewels until 1792 when it was stolen. It was recovered shortly after and has since remained in the French treasury. It is at present exhibited in the Louvre in Paris. It is one of the purest and finest of large diamonds.

The Orloff formed the eye of a Hindu idol when first discovered by a French grenadier in the eighteenth century. This soldier stole the stone and sold it to an English sea captain for $10,000 who, in turn, sold it to a Jew for $60,000. The Jew brought it to Amsterdam where it was bought by Prince Orloff, of Russia, for $450,000. By Orloff it was presented to Catherine the Second, Czarina of Russia, to allay the displeasure of the Empress. Catherine accepted the gift and the diamond has since remained among the Russian crown jewels. It has a slight yellow tinge and weighs 193 carats.

The Great Mogul, one of the largest and finest of diamonds, has unfortunately been lost, and our knowledge of it is confined to history. Travernier, the French traveller, saw it in 1665 at the Palace of Aurung-Zeb, ruler of Hindustan. He said it looked like an egg cut in half and weighed 280 carats, having been cut from a stone of 787 carats. It had the color of very pure water. It has been thought that the Orloff and Koh-i-noor are pieces of this stone, but such speculation seems to be unfounded.

The Florentine, also known as the Austrian Yellow or Tuscan, was first discovered by Travernier in the collection of the Grand Duke of Tuscany. The latter sold it to the Empress Maria Theresa, and it has since remained in the possession of the Austrian rulers. It is thought by some to have been owned by Charles the Bold, and to have been lost by him on the battlefield of Nancy, but this is regarded with scepticism by Streeter, an authority on its history. The stone

weighs 139 1-2 carets and is cut in the form of a nine-rayed star of the rose form. It has a citrine hue.

The history of the Beau Sancy is no less romantic. It is believed to have been owned by Charles the Bold, of Burgundy, who carried it on the field of battle at Grauson, where the conquering Swiss peasants trod it underfoot. A Swiss sol dier picked it up but, not realizing its value, sold it to a priest for a florin. The priest sold it to the burghers of Berne for a franc profit. The next time we hear of it is in 1570 when it comes into the possession of M. de Sancy, a Frenchman. One story is that de Sancy purchased it in Constantinople while he was French ambassador to Turkey, and another says that the King of Portugal pledged it to de Sancy, then treasurer of France, in return for a loan. According to this latter story, de Sancy soon bought it outright for 100,000 francs. While Henry of Navarre was king, de Sancy entrusted it to him. Henry sent a messenger with it to a money lender who, on its security, was going to furnish money to hire Swiss soldiers. On the way, however, the messenger was assassinated by robbers. De Sancy, confident of the messenger's integrity, had the body disinterred and found the stone in the stomach of the dead man. It was then sold by de Sancy to Queen Elizabeth and it remained in the English crown jewels until carried away by the exiled James II. to France in 1688. In 1695 James sold it to Louis XIV. It was retained by the French ruling house until stolen by robbers along with the Regent. It turned up in 1828, and was sold by a French merchant to Prince Demidoff of Russia. It passed from this Russian house to London merchants who in turn sold it to an Indian prince, Maharajah of Puttiala, where it still remains. The stone is almond shaped, facetted on both sides, and weighs 53 1-2 carats.

Tradition tells of the Piggott Diamond which was obtained by Clive in his Indian conquests and taken by Lord Piggott to England in 1775. It was obtained by Ali Pasha and crushed to powder by him just before he died.

The largest and most famous of the Brazilian diamonds is that called the Star of the South which was found in 1853 by a negro slave woman. It was sold later to a Paris syndicate

for $175,000. This company, in turn, sold it to the Indian prince, Gaikwak of Baroda, where it is still supposed to be. It weighed in the rough 254.5 carats but was cut to 125 carats. It was a dodecahedron, perfectly white itself, but in certain lights it gives off a rose tint.

The world's largest diamonds have come from South Africa. The Excelsior was originally a crystal of 971 3-4 carats, and was the largest found up to that time. The finder, a native Kaffir, picked up the crystal while loading a truck in the Jagersfontain mine. He secreted it from the white overseer but later surrendered it to the manager himself. The Kaffir was given a horse for his find. The excitement caused by the discovery was very great, for the stone was supposed to be of fine color and quality. The owner of the stone was unable to find a buyer willing to pay the fabulous sum he asked, so he had it cut into ten pieces. This work was successfully done in Amsterdam in 1904.

In 1895 a crystal which is often confused with Excelsior was found in the Jagersfontein mine. It weighed 640 carats and was cut into one of the most perfect oval brilliants in existence, weighing 238 carats. Its color, lustre, brilliancy, and purity are faultless, and it is considered the finest large diamond in the word. It was exhibited in the Paris Exposition of 1900 under the name of Jubilee in honor of Queen Victoria's Jubilee Celebration.

The Tiffany Diamond was found in the old de Beers mine, then owned by a French company, in 1877. It was cut by a French diamond cutting company in Paris in 1878, and bought by Tiffany and Co. of New York in 1879 through the agency of Mr. Charles Reed, the Paris representative of the firm. By this company it was imported into the United States where it still remains. It was an octihedral crystal of 280 carats when found and was cut into a stone having 103 facets. It is of a rich canary color.

The July Diamond was found in a Vaal river digging in 1872, and weighed 314 carats. It was cut into a stone of 120 carats and is now known as the Stewart Diamond.

The Hope Diamond is a blue stone weighing 44 3-4 carats. It was revealed in 1830 in the hands of Daniel Eliason, who

did not know its history. It is believed to have been bought in India in 1642 by Travernier and brought to France. It weighed 112 carats in the rough and was cut to 67 1-8 carats by the French king to whom it was presented by Travernier. It was stolen in 1792, and the Hope which was discovered in 1830 was so similar in color that they have been identified. It was bought from Eliason by Sir Thomas Hope for £18,000. His successor, Lord Hope, sold it to a New York firm which, in turn, sold it in 1908 to M. Habib.

The Braganza Diamond was found at a place called Cayde-merin in Brazil. It is still in the rough and no one is allowed to see it, but it is said to weigh 1680 carats. It is owned by the King of Portugal and its value has been estimated at £224,000,000.

PRODUCTION.

The chief producer of diamonds is South Africa, from which country 2,648,931 carats were sold in 1919. Other large producers are Brazil, India and Borneo.

Diamonds are not produced extensively in the United States. Desultory production occurs in several states, but in the majority of cases attempts to develop commercial diamond mines have proved disappointing. Arkansas is our chief producer, but diamonds are also found in California, Indiana, Idaho, Alabama, New York, Virginia, Texas and Illinois.

IN UNITED STATES

Arkansas

Arkansas is the only locality in North America where diamonds have been found in place. The producing area is in Pike County, where peridotite is intruded into sedimentary rock. These sedimentary rocks consist of strongly folded Paleozoic strata, overlain by Cretaceous beds. The peridotite has in most places disintegrated to a soft clay which is yellowish-green above and bluish below. This peridotite is known as Kimberlite in South Africa.

The control of the diamond-producing property in Arkansas has been acquired by the Arkansas Diamond Corporation of Virginia with a capital of $10,000,000. The property

owned by the Company is a tract of 900 acres, of which 60 acres comprise the diamond area. It is situated 2 1-2 miles from Murfreesboro, the county seat of Pike County. The roads are fairly good, and there is a railroad at Norvell, 8 1-2 miles distant. Coal, fuel-oil, and lumber are easily accessible, but labor is not abundant. The Company has installed a modern power plant, consisting of a 250-hp. automatic Atlas engine. Water is drawn from the Little Missouri River by a 1200-ft. wooden pipe of 6-in. diameter. Wood from the property can be used for fuel, although the cost of coal is scarcely greater. A Hardinge mill for washing the peridotite and clay has been installed.

Sampling and testing in the future are to be pursued on the company property on a large scale, the rock is to be excavated from long radial trenches traversing the pipe in several directions and converging at a given point. The average depth of the trenches will be 20 ft. The clay when thoroughly dried and then subjected to washing will absorb moisture rapidly and swell to almost twice its original volume; this permits the diamonds and associated minerals to sink to the bottom of the pan. The concentrates can then be separated from the diamonds.

From the first discovery in 1906 to 1913 about 1400 diamonds weighing 550 carats were found. During 1913 very rapid development occurred on the property of the Ozark Co. and on that of the Kimberlite Diamond Mining and Washing Co. The Arkansas Diamond Co. was idle during this year. The Arkansas Diamond Corporation then obtained control of the field and in 1917 produced 602 stones weighing 249 1-2 carats. However, due to war conditions, their production decreased to 110 stones weighing 48 carats in 1919.

Other States

Production in other states has been limited to mere casual discoveries, and no very serious attempts have been made to develop mines on a commercial scale. Kentucky, New York and Texas have peridotite rocks which look like diamond-producers, but as yet no diamonds have been found in them.

In South Africa

The chief source of diamonds in South Africa is the volcanic necks of pipes of kimberlite. These necks pierce a series of sandstones, lavas and shales, ranging from Carboniferous to Triassic in age. The upper part of the kimberlite, or weathered portion, is called the "yellow ground" and the lower part, or unoxidized zone, is called the "blue ground." The latter is the material now worked, and has to be disintegrated by weathering before the diamonds can be extracted from it. The pipes are generally regarded as volcanic vents, and the diamonds are supposed to be crystalizations from the magma.

The total production of South Africa in 1919 was 2,588,017 carats valued at $57,105,920. The total sales exceeded the quantity mined, drawing on the accumulated stock.

The largest output in any single district was in Kimberley which produced 1,396,733 carats worth $30,170,675. The deBeers Consolidated Mines, Ltd., whose profit in 1919 after expenditure had been deducted was $22,922,227, was the strongest company in the field. The company controls five mines: deBeers, Kimberley, Wesselton, Bultfontein, and Dutoitspan mines. The deBeers and Kimberley mines are becoming too deep to work, the rock shaft of the first now being 2,640 ft. deep, and that of the second being 3,601 ft deep. From 1909 to 1919 the deBeers group washed on the average 5,159,670 loads of blue ground a year which produced 1,508,997 carats worth $20,288,873. In 1919 all the deBeers mines washed 4,352,809 loads, obtaining 1,092,123 carats. A considerable increase in the cost of working, fairly constant in the three newer mines is more than offset by the higher prices obtained for the product. No development work was done in either the deBeers or Kimberley mines after 1918. In the Wesselton mine, 16,610 ft. of tunnels were driven in the blue ground, 13,290 ft. were driven in the Bulfontein mine, and 9,573 ft. were driven in the Dutoitspan.

The Premier Transvaal Diamond Co., Ltd., is another large producer; its profits after expenses were deducted being $6,350,493. In 1919 its mine washed 4,529,261 loads of blue

dirt which yielded 814,577 carats worth $9,531,718. The average depth of the mine was 275 ft. and the main incline into the mine had been extended to the 360 ft. level, where another onsetting station has been established. No further improvements will be needed for five years. A very large diamond, weighing 1500 carats was found in the Premier mine in 1919. It is a beautiful white stone, and is perfectly flawless. Some think it is a fragment of the "Cullen" diamond which was found in this mine in 1905, and which weighed over 3,000 carats.

The Vaal River deposits are now being mined by means of a diving bell caissen and compressed air. These operations are carried on by a new company having a nominal capitalization of 30,000 pounds ($1,458,000) and an actual working capital of £36,450. The bell is submerged by water ballast, and can be worked down to a depth of 65 ft. It is 15 ft. in diameter and is provided with telephonic communication.

The value of alluvial diamonds in South Africa for 1919 was: Transvaal, $5,744,156; Cape Colony, $7,417,967; Orange Free State, $173,745.

The average value, per carat, of South African diamond in 1919 was $18.43, which was an increase of 50 per cent over 1918. This increase was due partly to the increased intrinsic value of the stones, and partly to the policy of the companies to withhold distribution until a monopoly price could be obtained.

In Borneo

Due to English competition in the diamond-cutting industry, the Dutch are trying to enlarge the output of diamonds in their possessions in Borneo. Deposits here have been worked for many years, but native primitive methods have not been improved on, and during the four years 1912-1916 only 7,629 carats were produced.

All diamonds found have been alluvial diamonds, but the region is now being investigated and explored for possible diamond "pipes." It is said that a large Dutch syndicate has been formed for the exploitation of the Borneo fields, and that large concessions of territory have already been acquired.

In British Guiana

Between 1901 and 1918, 1,560,028 diamonds have been produced in this province. They weighed 157,513 carats. The average size increased from .09 carats in 1902 to .183 carats in 1918. In 1919 diamonds weighing 15,573 carats were mined, having a value of $401,518.

In the Congo Region

Between 1915 and 1919, 642,355 carats were produced here. In 1919 the yield was 275,000 carats, being worth $15 a carat, making a total value of $4,000,000. The largest single stone found during the year weighed 13 carats. During this year the Ferminiere Co. secured from the Kasai field a total of 215,000 carats.

In Brazil

Several provinces of Brazil afford diamonds, namely Bahia, Goyaz, Matto Grosso, Parana and Minas Geraes. In all of these except Bahia and Minas Geraes the mining is intermittent and consists simply of washing river sands in wooden bowls. Here the miners are called "fiscadors" and obtain only a precarious living.

Minas Geraes is the chief producer. Diamantina, which is the center of the mining here, is about 500 miles from the coast. The valleys of the Rio Jegnitinhonha and Rio Doce rivers are especially rich in diamonds and have been worked longest and most successfully. Here in dry seasons the waters of the rivers are diverted through flumes and the miners search the pot holes since here the swirling motion of the water erodes all rock except diamonds. Now, however, most of the pot holes have been worked and very few new ones have appeared.

In washing the gravel for diamonds the specific gravity of the different components are taken into consideration. After being shaken in a hod filled with water the diamonds are found at a very definite depth due to their specific gravity. The fine sand and clay is on top, then comes the diamond layer, and the lower layer is again sterile. This is due to the fact that the diamond has a density a little greater than quartz and tourmaline and much less than iron and titanium oxide. The washing machine whirls the sand and gravel in a water bath and the miners only search the middle layers for diamonds.

A New Viburnum.

B. F. BUSH.

Early last September, Mr. W. W. Ashe visited the writer at Courtney, Missouri, and while there I showed him some specimens of *Viburnum* that seemed to be undescribed, and also showed him living specimens of a form, the identity of which, had bothered me for many years. Mr. Ashe became very much interested in *Viburnum* species, and I requested him to make collections at every place he could last Autumn.

One of the forms he collected along the Gulf Coast in Mississippi, seems to be distinct enough to recognize as a species, although its character shows that it is closely allied to *V. scabrellum* (T. & G.) Chapman, but it differs from that species in several important particulars.

Mr. Ashe very kindly sent me all of his *Viburnum* collection for study, not only of this new species, but many sheets of *V. scabrellum* (T. & G.) Chapman, as well, and I take great pleasure in presenting this new plant as

VIBURNUM ASHEI (Bush, n. sp.

A shrub 1.5-2.2 m. high with arcuate stems covered with thin, dark, gray-brown bark exfoliating in thin scales; twigs bright tan or reddish-brown, more or less 4-angled, often elongated and wand like. Leaves opposite, stipulate, ovate, or broadly ovate, 4-6 cm. long, rounded, cordate or subcordate at the base, acute at apex, or rarely obtuse; 4-6 pairs of slender prominent, usually arched, often forking, primary veins; coarsely dentate or distantly serrate, or even crenate, the blades of full grown leaves glabrous above, glabrous below except for tufts of pale brown partly simple pubescence in the axils of the veins, and appressed pubescence of long simple pale brown hairs on the midrib; similar hairs usually also permanently clothe the grooved petiole which is .5 cm.-1.3 cm. long. Buds ovoid, acute, pubescent at apex, 3.4 mm. long, of 3-4 pairs of scales, lower pair short, dark red. inner green or tan. Inflorencence 5-7 but usually 6-rayed, 4-6 cm. wide, often long pedunculate; peduncles, as well as rays

and pedicels, usually sparingly fascicular pubescent, sometimes with simple hairs intermixed; bracts 1-1.2 cm. long; pedicels about 4 mm. long; bractlets 2-3 mm. long, sometimes persistent. Flowers unknown; base of calyx usually glabrate; calyx lobes acute or acuminate, erect on the fruit and coloring with it, and nearly as long as the slender 3-lobed style. Drupe, ripening in October, dark blue-black, glabrous, 6-8 mm. long, 3-6 mm. wide, usually broadly ovoid, sometimes oblong, the flesh oily, largely falling soon after maturing; seed 5-6 mm. long, usually about twice as wide as thick, very deeply grooved or rarely in narrow forms with groove obliterated.

Frutex 1.5-2.2 m. altus ramis arcuatis indutis cortice tenui griseo-fulvo, in squamas tenues excorticante: ramulis fulvis vel rubeo-fuscis plus minusve quadrangulatis saepe vemineis et elongatis; foliis oppositis, exstipulatis simpliciter vel late ovatis, 4-6 cm. longis, basi rotundatis, cordatis, vel subcordatis, apice acutis vel aliquando obtusis, crasse dentatis, vel longe serratis vel modo crenatis. Folia cum venis 8-12, tenuibus, eminentibus plerumque curvatis et furcatis. Laminae foliorum maturorum infra supraque glabrae, cum subfusca pubescentia in venorum axillis, et cum appressa pubescentia pilorum longorum fuscorum in veno medio; petioli canaliculati .5-1.3 cm. longi similibus cum pilis permanentibus. Gemmae ovoideae, apice acutae et pubescentes 6-8 squamas habentes, externae breves, rubeae; internae virides vel subfuscae. Inflorescentia cum 5-7 sed plerumque 6 radiis, 4-6 cm. lata saepe longe peduncalata. Pedunculi, radii et pedicelli sparse pubescentes cum pilis fasciculatis. Bracteae 1-1.2 cm. longae cum pedicellis circa 4 mm. longis, et bracteolis permanentibus. Flores ignoti. Calyx basi glaber cum lobis acutis vel acuminatis, in summitate fructus erectus at fructui colore similis, ejus quoque longitudine prope adaequat. Stylus tenuis trilobatus. Drupi coeruleo-nigri, glabri 6-8 mm. longi, 3-6 mm. lati, plerumque late ovoidei cum pulpa oleaceo, in mense Octobri maturant. Semen 5-6 mm. longum et 10-12 mm. latum, maxime vel non canaliculatum.

The foliage of this plant resembles that of *V. affine* Bush. It is separated from *affine*, however, by the prevailingly more distant and less prominent toothing of the leaves, by the

smaller and usually narrower and thicker fruit, prevailingly glabrate base of calyx, and thicker, deeply grooved and not flattened seed, and by the absence of stipules.

By its seed and fruit it is closely allied to *V. scabrellum* (T. & G.) Chapm., from which separated by having smaller fruit, smaller inflorescence, smaller and thinner foliage, which is glabrous above, and, except for axillary tuft of hairs and the simple pubescence on the midrib, is glabrous below. The leaves of *V. scabrellum* are pubescent above with short simple hairs and usually densely fascicular-pubescent beneath. The inflorescence of *V Ashei* does not exceed 6.5 cm. in width, and becomes glabrate; that of *V. scabrellum* is from 7 to 14 cm. wide and is usually densely fascicular-pubescent.

Southern Mississippi; W. W. Ashe, October, 1923. Type from Little Abolo-Chitto River, between McNeill and Caesar. Also collected along the Pascagoula River, George County, Miss., at Wilkinson Ferry. Along the Tallahoma River in Jones County, and along the Chickasawhay River near Leakesville, Greene County. The proposed species grows on the better drained sites along the banks of streams where it is usually associated with *Kalmia latifolia, Halesia diptera, Vaccinium virgatum, Rhus glabra,* water oaks, and *Quercus leucophylla.*

The American Midland Naturalist

PUBLISHED BI-MONTHLY BY THE UNIVERSITY
OF NOTRE DAME, NOTRE DAME, INDIANA

VOL. IX. SEPTEMBER-NOVEMBER, 1924. NOS. 5-6.

The Children's Museum of the Brooklyn Institute of Arts and Sciences, Brooklyn, New York.

ORIGIN.

The Building occupied by the Children's Museum was built as a residence in 1867, the house and grounds generally being known as the Adams Estate. About twenty-five years later the City of Brooklyn bought the estate for part of its park system, and named it Bedford Park.

Plans were being made to remove the house when, in 1893, the old Washington Street building of the Brooklyn Institute of Arts and Science was destroyed by fire. In order to obtain storage space for the collections, apparatus and books that were saved, the Institute leased the Adams house from the Department of Parks for the nominal sum of one dollar per year, the lease to be renewable. This arrangement is still in effect.

In 1899 the present museum building of the Institute on Eastern Parkway was opened, and the collections and a portion of the books were transferred to it. At the same time the favorable location and the large, yet home-like structure of the house suggested to Professor William Henry Goodyear, curator of fine arts in the Institute, that it might be turned into a special museum for children. On January 17, 1899, he communicated the suggestion to Franklin W. Hooper, director of the Institute, at the same time recommending the purchase of various educational charts and models from the Musée Scolarie of Emile Deyrolle, Paris.

The plan was approved and a curator, Miss Anna Billings Gallup, appointed for the new museum. As preparation for the work Miss Gallup was given a four months' leave for study of museums and other educational institutions of

Europe. The study covered twenty-eight museums in seven countries, and many consultations with museum experts who were particularly interested in interpreting the museum idea for children. Today a curator, though it might be to his advantage to journey to Europe, would not be forced to do so; every American Museum of importance is making some effort to reach children, and most of them are making the juvenile work a prominent part of their programs. But things were very different a quarter of a century ago, when even our best museums were largely store-houses of mounted specimens.

The purchases recommended by Professor Goodyear were made, and to the stock of models and charts were added small collections of birds, insects, shells, and minerals, and the whole were installed in a few rooms of the old mansion. With this small equipment the Children's Museum, the first of its kind in the world, was opened to the public on December 16, 1899.

BUILDING.

The structure which houses the Museum, as said, was built in 1867 as a residence, at a time when much of the locality in which it was situated was covered with thick woods and one might have a whole city block for his grounds. The mansion is about fifty by one hundred feet in greatest measurements, with the ceilings of the first floor fifteen feet in height, and those of the second floor twelve feet. The second story has a mansard roof with dormer windows that have a moderate offset.

The windows are numerous and large, and let in a great deal of light that is tempered somewhat by the nearby trees. The large rooms and high ceilings allow for cases of adequate depth and height for all of the exhibits, while the fact that the building was once a home, adds cheer. Everything possible is done to save the children from museum fatigue.

The walls are painted light buff, and the framework of the cases, which is of wood, white. The floor is covered with brown cork linoleum. Tables, desks, and similar furniture are golden oak. Here, as in the general arrangement, every effort is made to preserve informality and cheer. The lecture hall,

measuring twenty-eight by sixteen feet, is furnished with folding chairs, blackboards, and other equipment, as well as a motion picture machine, stereopticon, and screen. The cost of these was $600, $250, and $50 respectively.

ORGANIZATION.

The Children's Museum forms a specialized part of the work under the Department of Museums of the Brooklyn Institute of Arts and Sciences. The complete organization of this institution includes these divisions:

1.—The Department of Education, with headquarters in the Academy of Music building.

2.—The Department of Botanic Gardens, which maintains a large botanical garden with headquarters on Washington Avenue.

3.—The Department of Museums, which maintains the main Brooklyn Museum at Eastern Parkway and Washington Avenue, and the Children's Museum, in Bedford Park.

The laboratory formerly maintained by the Institute at Cold Spring Harbor, Long Island, has been given independent existence within the last few months.

The executive head of the Department of Museums exercises direct control over the larger museum, and general control over the Children's Museum, but the direction of internal affairs of the latter is left in the hands of its supervising officer, the Curator.

STAFF.

As it is at present organized, the staff of the museum consists of the following persons:

Director of Museums, Brooklyn Institute of Arts and Sciences, ... William Henry Fox, A. B., Litt. D.
Curator ..... Anna Billings Gallup, S. B.
Assistant Curator ..... Dorothy F. Goerz, A. B.
Museum Instructor and Guide ..... Edith Campbell, A. B.
Secretary ..... Marguerite Wilson Carmichael
Librarian ..... Miriam Stanfield Draper

ARTISTS IN PREPARATION OF EXHIBITS.

Geographical Models ..... Dwight Franklin
Historical Models ..... Agnes E. Bowen
Children's Loan Collection.
Franklin W. Hooper Memorial ..... Clara L. Parsons

WOMAN'S AUXILLIARY OF THE CHILDREN'S MUSEUM.

President ..... Mrs. I. Sherwood Coffin
Chairman, Executive Board ..... Mrs. John J. Schoonhoven

Ordinarily there are two assistant curators, one in charge of lectures and the other having charge of the exhibits. During the wave of "war economy" the City removed provision for one of these, but efforts are being made to have the position restored. There is a janitorial staff of five.

The instruction staff are college graduates, who know the subjects they teach and understand how to present them to children. The museum guide meets the children in the exhibit rooms, answers their questions, directs conversation, and conducts the museum games. Hers also is the task of securing identification of the many objects which the children pick up and bring to the museum in search of information. A great deal of the same sort of work falls upon the librarians, who make it a point to encourage the children to read about their finds.

In addition to the regular staff, there are many volunteers who from time to time assist in the work of the Museum.

THE WOMEN'S AUXILIARY.

To quote from the constitution, "The purpose of the Woman's Auxiliary of the Children's Museum, of the Brooklyn Institute of Arts and Sciences, shall be the upbuilding of the Museum, the advancement of its interests, the broadening of the scope of its educational work, the increase of its collections, and the enlargement of its equipment in every branch of its activity." The function of the Auxiliary is to assist the Governing Committee of Museums which is composed of Trustees who control Museum Departments of the Brooklyn Institute.

The Woman's Auxiliary had its inception at the time of the presentation of their first Dwight Franklin Geographical Model to the Children's Museum by the Brooklyn Woman's Club.

An appeal was made in the Long Island Council of Women's Clubs to continue this work, and a committee was appointed in January 1915 to interest the clubs of Brooklyn and Long Island in completing the equipment of a Geography Room in the Children's Museum. The appeal was successful, and a sum sufficient to complete the work was raised.

After the installation and formal presentation of these models in the winter of 1916 a few women organized to do systematic work for the Museum. A Constitution and By-laws were adopted; officers and executive board elected, and the Constitution and By-laws were approved by the trustees of the Brooklyn Institute of Arts and Sciences.

From the beginning the Auxiliary has had an Educational Secretary who has directed and inspired the Executive Board. Through her activity, much misdirection of energy has been avoided. The organization functions through its three standing committees and at the annual meeting reports of these committees are read. The committees are the following:

MEMBERSHIP COMMITTEE.

The members of this committee by individual contact in the community seek to enlarge membership, make the Museum better known, and its ideals better understood.

SPEAKERS' BUREAU.

The members of the Committee volunteer their services to address clubs, societies and schools on topics relevant to the work or needs of the Children's Museum. Through the radio a series of lectures have been broadcast with desirable results. One of the series by "The Museum Lady" includes in its program:

A talk on one of the exhibit rooms. (Each time a story is woven about a different room.)

A group of poems suggested by the room's exhibits.

A group of children's songs. (Nature, trees, butterflies.)

AMERICANIZATION COMMITTEE.

The Americanization Committee carries out a definite educational program which links the Museum with new groups and educational centers, and is an additional means of carrying the work to children.

Through the activities of this Committee a Field Secretary has been put to work in the community. Her work is to bring groups to the Museum—to make new connections between the child public and the Children's Museum. The work is approached in two channels: first, through the schools, both private and public; second, through the children's own organizations, such as Boy Scouts, Girl Scouts, Woodcraft and Campfire Girls. Thus children are drawn to the Museum both in school and in leisure hours. The Field Secretary further seeks for increased coöperation with the various departments of the Board of Education, the district superintendents, principals, and teachers.

The Auxiliary not only contributes to the upkeep and activities of the Museum but secures valuable gifts and additions to the collections. Perhaps the most significant of these contributions is the $10,000 fund for the Franklin W. Hooper Memorial loan collections. Other gifts range from equipment for Museum hospitality, to a much needed motor car.

The Woman's Auxiliary pays the salary of a qualified teacher to conduct the summer field trips, an annual feature of the vacation program. To augment the summer program, the lecture room is cleared of its benches and chairs, and here the children bring their specimens from the field trips, and mount, study, and label their collections.

Realizing the limitations of the Museum's work because of inadequate space, the women of the Auxiliary initiated and maintained a determined effort to secure a house and some ground across the street from the Museum, on Brooklyn Avenue between St. Marks Avenue and Prospect Place. The campaign ended March 2, 1923, when the Board of Estimate and Apportionment of the City of New York voted to take over the old Smith homestead as Park property; as with the

Museum grounds, the land to be used by the City as a public park. At this writing the City has voted to appoint an architect to draw plans for remodeling the building for Museum purposes, and it is expected that work speedily will follow the completion of these plans.

FINANCE.

The Children's Museum receives its principal support from the City of New York, Borough of Brooklyn, which furnishes about $20,000 annually. The Woman's Auxiliary has a budget of $7,500 per year. This covers its own operating expenses as well as its contributions to the museum funds. In addition there are contributions from purely private sources, ranging from a few dollars to $10,000 as the maximum. Many specimens and books are received by gift.

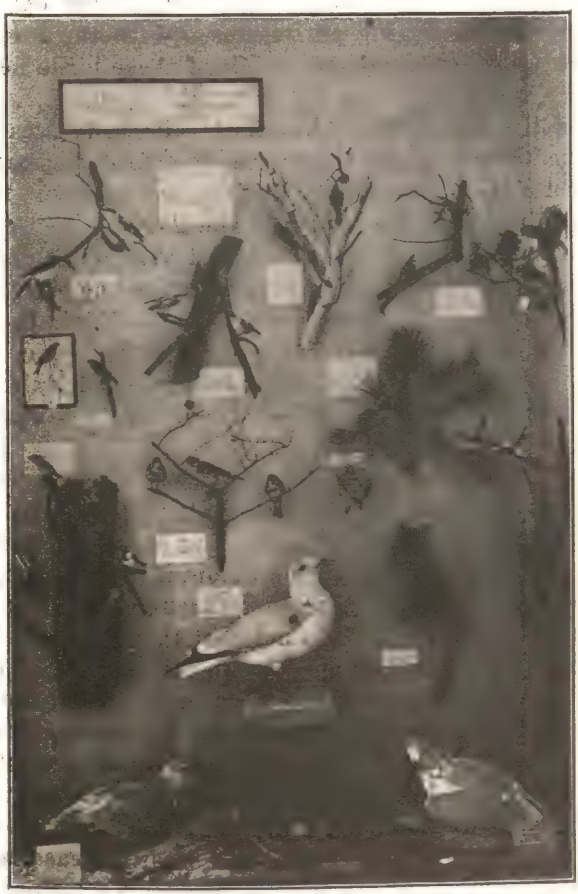
COLLECTIONS.

The equipment of the museum is based on a thorough understanding of the needs and interests of children. Objects to be displayed are selected with reference to the capabilities of the child's mind, and the way they will fit into a story-telling exhibit. Children's Museum labels, like Children's Museum specimens, are carefully selected and phrased in simple words, as well as being printed in clear type.

BIRD COLLECTION.

The first room to the right of the wide corridor which one enters on coming into the building is devoted to birds. The room itself is a cheery, home-like place with double doorway and large bay windows, in one of which a balanced aquarium glows green and gold with its water plants and bright colored fish.

Special prominence is given to the birds of Prospect Park, since they are the ones which Brooklyn children can see and study. One hundred and sixty species have been recorded by the Bird Lovers' Club, and all of the important ones are shown in this room. In the cases around the wall the birds are placed in life like attitudes (they are excellently mounted) in accessories suggesting the natural surroundings. The arrangement



BIRDS THAH CAN BE SEEN IN WINTER—A CASE IN THE BIRD ROOM.

is not systematic, but rather in accordance with the seasons during which the birds may be seen. They are grouped and labeled as follows:

Case 1.—*Permanent Residents*—Birds that can be seen in Prospect Park during all seasons. With the exception of the Black-crowned Night Heron, all of these birds nest in the Park.

Cases 2 and 3.—*Winter Residents*—Birds that can be seen in Prospect Park during the winter months—December, January, and February. These birds have arrived from the North and will pass the winter in the Park.

Also in Case 3 are the occasional visitants, birds which visit the Park at irregular intervals during the Winter.

Cases 4, 5 and 6.—*Summer Residents*—Birds that can be seen in the Park during the summer months, June, July and August. These birds have arrived from the South to spend the summer and to nest in the Park, where they may be seen by the children who visit the museum.

Occasional visitants also are in Case 6, while Cases 7 to 11 inclusive have spring and summer migrants—Birds that can be seen in the Park during the spring months, March, April and May; and during the Autumn months, September, October and November. All of these pass through the Park on their way North and South, but do not nest there.

Although the limited space will not permit of elaborate habitat groups, an attempt has been made to tell the life history of the birds, or to illustrate some interesting facts about them. In many instances male and female are shown together with their nests and eggs. The difference between the colors of adult and young, or between those of the same bird at various seasons thus is emphasized, and the seasonal rhythm of life indicated in a small part, at least. Variations in birds of the same general sorts are illustrated by such contrasting types as the eagle and Pygmy owls. The specimens are helped out by lists which contain names of the birds of the three different seasons, information as to the particular months of arrival and departure, and accounts of peculiar feeding and nesting habits.

The large central cases contain birds from all parts of the

world, interesting because of their plumage, grotesque form, or unusual habits. Among these are the peacock with tail spread, the lyre bird and the penguin and a condor from South America, the flamingo, cassowary and quetzal. These cases are appropriately labeled, "Birds we read about."

When the children begin to study birds, they first learn to name the external parts of the body from a chart. Using this terminology they describe the birds in the museum accurately in preparation for their field trips. If twenty-five birds are correctly identified, a child is privileged to take a mounted bird home or to school. Identification of a hundred birds in the museum entitles the child to borrow a pair of nature study glasses for use on field trips to Prospect Park.

ANIMAL TYPE ROOM.

At the end of the corridor is the animal room, the parallel to the "Phylogenetic Hall" in large museums. Since general exhibits are impossible, the specimens are restricted to types which portray the development of animal life from its lowest forms to the tailless apes.

The line of increasing complexity is indicated by arrow-marked direction labels placed in each case. Strips of black molding carried down the back walls and across the bases separates the phyla while black cords outline the minor divisions. Thus, by size of label and width of outline, the observer may know at a glance which groups are co-ordinate. A case list enables him to locate quickly whatever he wishes to find.

Another distinguishing feature is the color of the bases. For all the lower forms—creatures whose habitat is the water or the sandy shore—they are gray. For the mammals they are black, or very dark, as are also the bases for models, the shelving, and the frames. Aside from the convenience of this plan the advantage of the black and gray as a setting becomes evident when brilliantly tinted sea forms are placed against it or when models which show the gorgeous hues of the living animal are introduced.

The minutest form of animals of all classes are represented by pictures. The largest animals, such as the elephant and whale, also are shown by pictures as well as models. In this

systematic evolutionary series, every animal is seen in its relation to other animals, and impresses its part in the story of classification.

At the end of the corridor adjoining this room is a supplementary collection which gives special emphasis to groups of reptilia, amphibia, and mollusca of Long Island and the vicinity of New York.

ONE OF THE PHYLOGENETIC CASES.

ANIMAL FAMILY ROOM.

Upstairs is another animal room, where animal families are shown in reproductions of their natural surroundings. The purpose of this room is to show animal homes and families and their care for their young until the latter are old enough to take care of themselves.

In a case in the center of the room is a scene representing the gnawing mammals,—a muskrat family and their hut, such

as may be found in the marshes near Newark, New Jersey. The male parent is seen swimming with a bunch of grass and mud to be used in repairing the hut. The other parent is eating a piece of sweet flag-root, and a third rat is sunning itself on a hummock of reeds. A young muskrat, about four weeks old, is on the edge of the hut while cuddled in the nest are several very small ones not more than two weeks old.

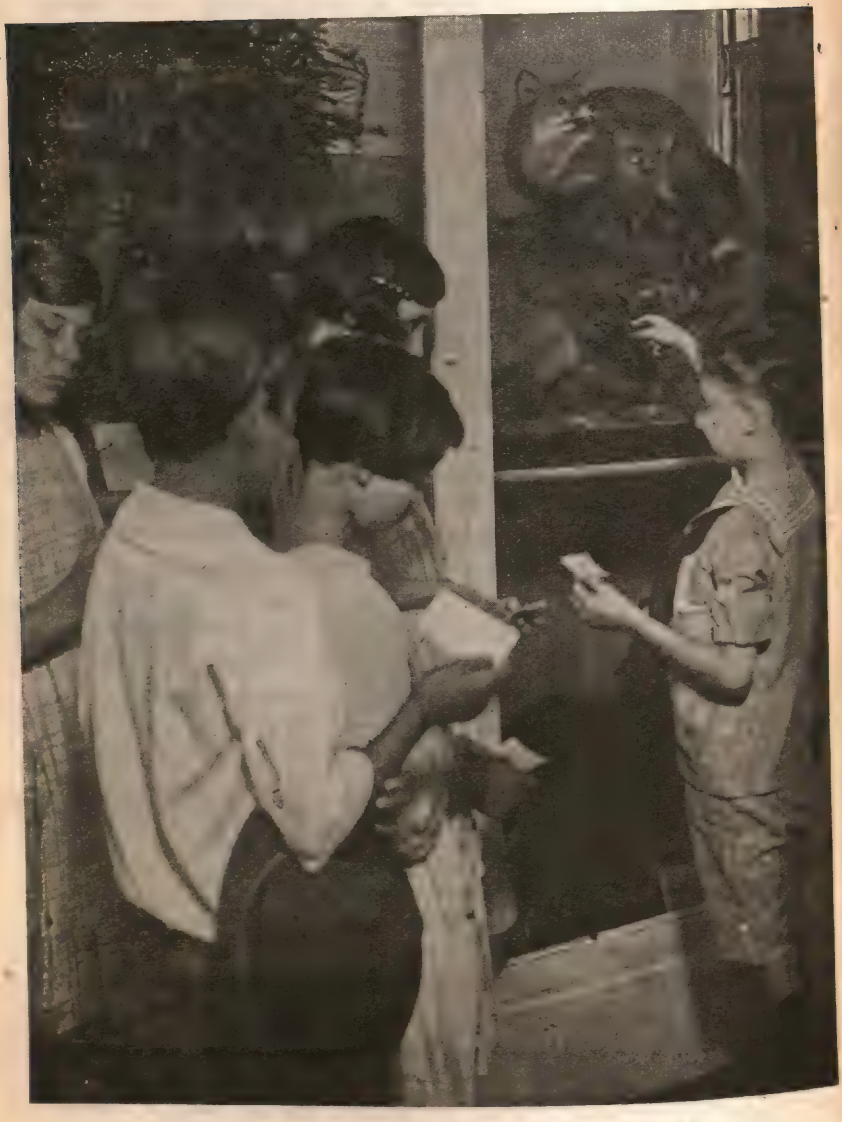
Some of the other groups in the wall cases represent the red fox, the eastern skunk, Greenland eider, young seal, American crow, woodchuck, mourning dove and Virginia rail. This secretive bird, a common summer resident of Long Island, arrives in April or May and remains until late in September. The group shows several in their favorite haunt of weed marshes overgrown with reeds and grasses. Swiftlets and their edible nests are attached to a portion of a wall. One case contains a setting hen and her chicks, things common enough to country children, but by no means so familiar to Brooklyn youngsters. Some bright verses appealing to the children take the place of the explanatory label for this group.

One case is devoted solely to color. In it are brought together a few natural objects both noticeable and pleasing for their beautiful shapes and colors—a museum parallel to Haeckel's remarkable "Art-forms in Nature." There are birds and insects, rocks and minerals from the earth, and multitudes of animals in the sea whose colors are quite as beautiful as one can find in any art gallary. The "color case" presents this fact to children.

SHELL ROOM.

In the corridor of the second floor are wall cases filled with shells from all parts of the world. There are five hundred species on exhibition, covering all the larger groups of the phylum Mollusca, and a great many of the smaller ones. As in other exhibits the frames of the cases are white, but a black background has been used in order to give to the collection that richness which can be attained only by use of black.

The "shell game" is conducted much as is the "mineral game." A cabinet containing duplicate specimens is unlocked and the shells are given the children to identify. In



THE ANIMAL GAME, ANIMAL ROOM.

this way they have the pleasure of handling the specimens and examining their beauties at close range. It is a poor game indeed in which a few youngsters do not find something to excite their curiosity and send them to the library in search of information.

INSECT ROOM.

On the main floor, opposite the Bird room is the Insect Room, where the children find moths, butterflies, beetles, dragon flies, grasshoppers, hornets and bees found in Brooklyn.

Besides local specimens there are foreign and tropical insects,—gorgeous colored moths from Africa and South America, and Brazilian beetles. These are to show that tropical insects are more brilliantly colored than native species. Some curiously formed insects also attract attention.

In this room is a large dissectible model of a silk worm. Silk caterpillars of natural size and spun silk, of different varieties are exhibited.

Not only are seen beautiful insects but larvae and caterpillars that damage our trees and injure our crops. A series of small framed case exhibits show the development and life history of the Brown tail moths, and their destruction to the leaves and bark of trees.

There is an exhibit to teach the children how they may become insect collectors. Here are butterfly nets, killing bottles, spreading boards and all the paraphernalia needed by the amateur collector.

BUSY BEE ROOM.

A "Busy Bee Room," or "Children's Laboratory" is furnished with tables where children work under the direction of a Museum instructor mounting butterflies, analyzing flowers, testing minerals, and modeling and drawing from mounted birds. The collections made by the children are displayed from time to time. A bee-hive of living bees with glass sides through which the children can see the bees at work, is a center of attraction during the active season. In late May the bees generally swarm and there always is a scramble to

get the swarm out of a tall tree in Bedford Park and into a new hive. By September there are often from 50 to 70 pounds of delicious honey ready to gather.

PLAYING A GAME IN THE SHELL ROOM.

MINERAL ROOM.

The Mineral Room is on the first floor at the left of the entrance. The specimens on exhibition are classified and arranged from an economic standpoint, since this arrangement

appears to be the one most intelligible and significant to the child. Wall cases contain the mineral and rock collections, while table cases and a smaller wall case display the semi-precious stones and the gems.

A model of a blast furnace occupies the center of the room and presents the entire story of the conversion of iron ore into the "pig" or bar, including the delivery of car loads of ore at

SPECIAL PROTECTIVE RESEMBLANCE—A SMALL CASE IN THE INSECT ROOM.

the furnace. Electric lighting gives to the furnace and molten metal a realistic glow.

Interest is aroused by the cases containing beautiful forms of quarz, precious stones, and "birthday stones." These are placed in careful, attractive grouping to appeal to the child. Legends connected with the birth-stones are given in rhyme.

In the wall cases are exhibits of minerals and rocks, ar-

ranged in an orderly manner—one section to iron minerals, another to manganese, cobalt, nickel, tin, zinc, and so on, another to the calcium minerals, and thus through the series. The exhibit is one that will appeal particularly to the child who wishes to make mineralogy a hobby, or to the boy who has a liking for mechanics and chemistry, and wishes to know the nature of the substances with which he works.

The rock collections are arranged in the conventional manner, according to origin. Labels explain the lava origin of

A HALF HOUR WITH THE MICROSCOPE, BUSY BEE ROOM.

igneous rocks, the nature and formation of sedimentary beds, and the processes by which rocks are metamorphosed. To show the practical side of geology and mineralogy, the cases contain articles used in every-day life that are made from the metals and stones exhibited. This part of the exhibit, of course, allows for the introduction of local products, and a museum in Georgia or one in Colorado might to advantage have a very different series of tools and utensils.

To stimulate the study of minerals, trays of labeled specimens which the children may handle are furnished them, so

that they may study such properties as composition, weight, and hardness. When they have learned a sufficient number to become acquainted with the general basis of classification, they are given large trays of unlabeled specimens which they are to identify by comparison with those on exhibition. On the Children's Museum plan, the study of minerals becomes instructive play that leads to further interest.

BOTANIC EXHIBIT.

A part of the botanical collections, and the one which first secures the attention of the visitor, is placed in the wall cases of the lower hall. It consists of about fifty enlarged dissectible paper maché models of flowers, that are part of the original equipment for the museum purchased from Deyrolle's "Musee Scolarie." The models lack the fineness of detail to be found in some of the celluloid and wax models from Germany that have been used with great success in the Education Museum (now disbanded) at the University of Chicago, but they possess much greater durability. The modeling is accurate, as also are the colors, and what little of beauty is lost is more than made up in service.

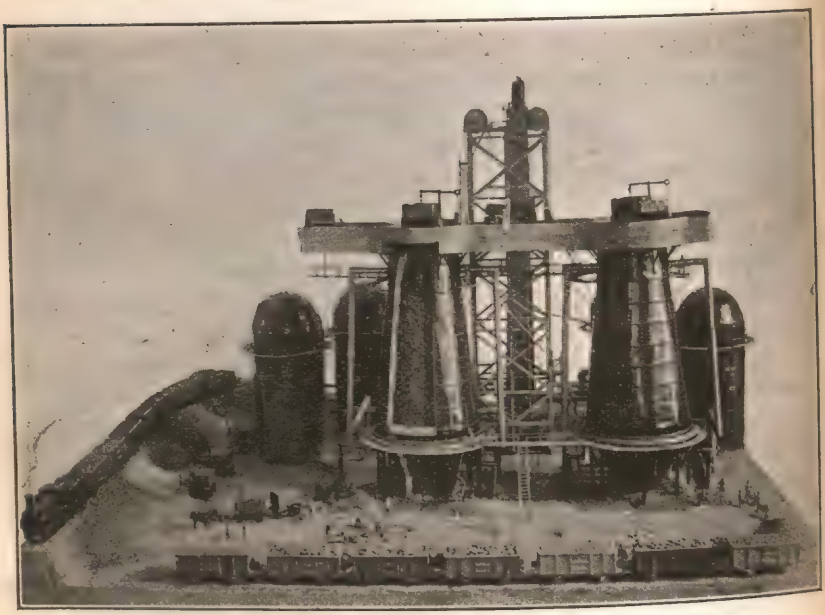
With a textbook of botany and occasional help from a museum instructor the children easily learn the parts of a flower, the uses of the parts, and the characteristics of structure on which classification is based. The extent of the information sought, is regulated by the age of the child and his position in school, but the models work equally well with grade children and high school pupils. They are accompanied by charts which show not only flowers represented by the models, but the plants on which they grow. At various lectures colored lantern slides of many of the plants growing in their native habitats are shown.

In the early spring the Busy Bee Room is supplied with many clear glass vases filled with water and containing living twigs of common trees, and the buds unfold rapidly in the sunny windows. It is common for the children to ask for pencil and paper so that they may draw the falling bud scales, or the tiny flowers of the unfolding bud. Here again is a natural and spontaneous combination of nature study and art,

the lack of which is accountable for many monstrosities of the average student's "paint book." There was much truth in the comment of a critic upon a water-color exhibit by a famous geologist, "Science is not an art, but it is plain to me that art stands badly in need of science."

HISTORY ROOM.

The history collections occupy two rooms and a portion of



MODEL OF A BLAST FURNACE.

the hall on the second floor of the building. In the early work of the museum little attention was given them, and in 1905 they consisted of but a few objects of historic interest, exhibited in cases. They interested the children as curiosities or "relics," but gave them no general conceptions, and so obviously were insufficient. As an experiment a single model of a group was put together out of pasteboard. The children showed such an interest in it that a plan at once was formulated to present a general survey of American history by

means of miniature groups and type models. As in the rest of the museum, local interests were kept in the foreground, and things which the children knew were connected with those not as familiar.

It must be admitted that the New York region has more historical associations than many other districts, and that those associations are of the sort which attract the youthful mind. Thus Hudson, always a hero with boys, doubtless landed at Coney Island. A significant battle was fought in Brooklyn, and the British prison ships were anchored in the Wallabout; Lafayette lived for a time in Brooklyn, near the Fulton Ferry; Robert Fulton often stayed at the Remsen Mansion on Hicks Street; Plymouth Church sent its own regiment to the Civil War, and its pastor, Henry Ward Beecher, set the cause of the North before England. A city in Illinois or Iowa would find it difficult to discover readily so many incidents of national and international connection in its past, yet it would be able to follow the general plan without difficulty.

The models are carefully prepared and accurate in every detail. They are grouped in five divisions, and since they present the subject from the historical standpoint, it is natural that they should begin with the first European explorers and sovereigns to take an interest in the development of America. Portraits of rulers under whose patronage navigators set out on voyages of discovery, pictures of some of their ships and incidents connected with their departure from Europe and their arrival in America supplement the groups. There is a model of Hudson's ship the "Half Moon," and a considerable series of prints from the Moran historical paintings in the Smithsonian Institution. The primitive Indian inhabitants are represented by a picture of the "Marriage of Pocahontas," a collection of ornaments and wampum, and examples of domestic utensils.

What Hudson saw as he sailed up the Narrows is portrayed in a group representing Indians digging for clams on the Gowanus beach, with a cornfield in the background. The flat on which the field is located represents the first land bought by white settlers on Long Island. The children's attention is called to the fact that the Island was called by the

Indians "Seewanhacky," or the Island of Shells, and was the great aboriginal mint of the region, producing immense quantities of shell money, or wampum.

Following the Indian group is a series of six models showing the four important types of settlers in America: the Spanish, French, British, and Dutch. Here the models have a

GETTING DOWN TO BUSINESS—MINEROLOGY GAME IN THE MINERAL ROOM.

general application equal to or even greater than that for the Brooklyn district, and may be reviewed in detail. The arrangement is chronologic, following the order of settlement by the several nationalities, beginning with that by the Spanish in 1565. With each group is the national flag of the home land.

Model 1.—*Spanish Type-Scene*—"Priest and Soldiers Plan

a New Mission," shows a Franciscan friar listening to a Spanish soldier who is urging the establishment of a new mission. The setting is a mission ambulatory and garden in the Southwest. The idea is taken from the Old Mission in Santa Barbara.

Model 2.—*French Type-Scene*—"Jesuit Arrives at Mission Station." Father Jacques, the fearless Jesuit missionary among the Northern New York Indians, the first white man to cross Lake George, is being rowed by one of the Huron Indian converts to a mission outpost at the edge of the wilderness, on the northern New York border. The Jesuits ministered to the French villages along the water-courses which for many years were the only "roads."

Model 3.—*Cavalier Type* (*first British*) *Scene*—"The Cavalier Comes to Call," pictures the meeting of a gentleman of fashion and his fiancée at the garden porch of an old red brick Virginia homestead. Vast tobacco fields appear in the background.

Model 4.—*Dutch Type-Scene*—"Indians Selling Furs to Dutch Traders at Fort Orange," shows a trading post in the forest at Fort Orange (Albany), the trader buying bear skins from friendly Indians, while his wife, two dogs and two pigs look on. This expresses the fact that the Dutch remained here at first entirely for trade and because of commerce cultivated the friendship of the Indians, ommitting the idea of creed in their dealings.

Model 5.—*New-England Type* (*second British*) *Scene*—"The Minister Calls on the Family." The visit of the clergyman of the Congregational Church upon a prominent family of his parish. He is having the usual refreshments of Bohea tea and sponge cake. The New Englanders settled as congregations, in parishes, each with a clergyman as a dominant influence.

Model 6.—*Quaker Type* (*third British*) *Scene*—"A Quaker Quilting Bee." In this group the very name sets forth the religious idea. A "name-quilt" is being made for a bride's "setting-out." The frame is standing in an old-fashioned kitchen through whose open "entry" door arrives one of the men

guests for the supper which is to come at the end of the quilting bee.

The third section contains eight groups, six of which deal with wars in which the people of the United States, and the Colonies which preceded them, have engaged. The exhibit opens with photographs of the presidents as commanders of the army and navy, accompanied by a brief account of each administration, a history of the country's flag, and a series of small replicas of the flags used at various periods.

THE MINISTER CALLS ON THE FAMILY—A NEW ENGLAND SCENE IN THE HISTORY ROOM.

The first and second models antedate the Revolution, one portraying Miles Standish, the first commissioned military officer in New England, and the other a colonial frontiersman attacking an Indian. The background of the Standish group shows the fort and first meeting house on Burial Hill, Plymouth, protected by four small, quaint cannons from the "Mayflower." The frontiersman shows the clothing and military equipment of the time, including cartouche-box and flint-lock gun.

The Revolution is represented in a group showing a meeting between Washington and John Paul Jones—both characters of vital interest to school children. Two groups belong to

the War of 1812, one showing the Dey of Tripoli signing the treaty between the United States and Algiers, and the other Perry on the deck of the "Lawrence" during the Battle of Lake Erie. Other groups show light artillery in the Battle of Palo Alto, during the Mexican War, "Lincoln at Headquarters at Antietam," models of the "Monitor" and "Merrimac," and an incident in Crook's campaign against the Nez Perces, in 1877.

The models are placed in wall cases, and although they vary in size, average twenty-two inches in length, twelve in depth, and fifteen in height. Each group has its separate case and illumination, and stands as an individual unit in the general exhibit. Walls and other space are used to display the individual objects such as constituted the entire historical collections up to 1905.

Each model has its own label, where the story is continued in some detail. The group is designed to tell its story at a glance, even though it may tell more on close study. The duty of the label is to bring out the underlying historical motive, the chronological position of the group, and the reason why the particular subject was chosen. Thus the child, first attracted by what is pictured or shown in model, is given an easy way to discover the whole story, and thus is led by gradual steps into the study of history. The following label deals with a group that has particular appeal, and illustrates the point.

LINCOLN AT "HEADQUARTERS" AT ANTIETAM.

"As Commander in Chief, President Lincoln sometimes visited the army of the Potomac when it was in northern Virginia, in the early part of the War. The model presents such a scene, soon after the Battle of Antietam, when he has come to confer with the commanding officer, Major General George B. McClellan, who stands at the tent entrance. Brigadier General Seth Williams, Assistant Adjutant General, A. P., is seated, and Major General John A. McClernand is about to bring his chair to the table. He has just arrived from the West for a short stay in Washington, and is present not in an official capacity, but as the guest of the President, who was

his close personal frined. A conference at which terribly destructive measures against the Confederation are to be planned, is to begin, when General Williams happens to glance toward the shell-shattered house to which the last rays of

THE MERRIMAC AND MONITOR, AND OTHER SHIP MODELS IN THE HISTORY ROOM.

the setting sun give almost the appearance of occupancy and evening lights, and he sees toys under the burned and broken trees that border the driveway. He gains the attention of the others by tones of pity and surprise, "Look at those toys—

and the little sunbonnet. It appears almost as fresh as if just from the laundress' hands. The family must have picked up their child in haste and fled in terror from this house." "I don't wish to look at them," says President Lincoln. "It is dreadful that the little children of this nation must suffer from war and its memories."

This is a true incident. The officer who told it said, "We forgot the enemy in pitying the terror of these American parents who must have seized their baby from her play place and rushed to a place of safety. It was difficult to return to plans for 'wholesale destruction' of the enemy with those toys beside us."

The fact that here is the field headquarters is shown in the Army of the Potomac "Headquarters" flag above the tent. The "colors" are also suitably placed. The usual folding camp furniture of that period is seen, and the "candle-shells" upon the table are such as officers carried during the Civil War. The candle sockets unscrew and rest in the shells when not in use, and the two shells screw together, over the sockets, thus making an object that occupies but little space. The ink is also in screw-cases. The maps are carried in large envelopes, and, like the tent and the furniture, are dirty from much handling. At the rear of the tent, outside, three orderlies—who typify the extreme youth of the majority of men composing both Federal and Confederate armies—are conversing in low tones, one of them pointing to the officers as he speaks. The orderlies' horses are back of the tent, so cannot be seen.—*Miss Agnes E. Bowen.*

The entire group of history models are the work of Miss Agnes E. Bowen, whose home for many years was in Brooklyn. Throughout her life Miss Bowen was keenly interested in local history, having been initiated into the study as a child by her father. This interest, coupled with the idea of visualization, eventually resulted in the history groups, whose parallel in the large museums of the country is to be found only in the remarkable full-size historical groups which so impress the thousands of visitors at the Milwaukee Public Museum.

GEOGRAPHY ROOM.

Geography, like history, is presented mainly by means of group models. The subject is introduced by several cases of foreign dolls in appropriate costumes that line the walls of the corridor between the rooms given over to these two sciences, but it is introduced only. The real substance is in groups.

The Geography Room is one of the largest on the second floor, and is decorated in buff, with neither window nor ceiling light. About the walls is a series of white cases, containing large panes of glass. The pressing of a button reveals the most up-to-date thing in museums, devoted to an entirely new purpose: built-in, electrically lighted cases containing habitat groups of man.

The groups, executed by Dwight Franklin, portray primitive life in a manner that is vivid to large children and thoroughly comprehensible to small ones. By their models and background they indicate the "climate of a country—whether frigid, tropical, or temperate: the physical character of the land, whether mountainous, plain, desert, or jungle: the natural flora and fauna peculiar to the region, and natural resources of the country: the characteristics of the people that inhabit the country: the manner in which the lives and occupations of the inhabitants are influenced by their environment; and the extent to which development and civilization are limited by the geographical and climatic conditions of the countries in which the different peoples live. More particularly the models instruct the study of the earth as the home of man." A map of the world indicates the localities of the peoples and countries represented by the models.

The models are:

Harpooning the Walrus.—A section of the northwest coast of Greenland inhabited by the Smith Sound Eskimos.

A Quiet Evening at Home.—A cross section of the hive shaped house or igloo of the Smith Sound Eskimo, revealing their indoor life.

The Lapps.—A section of country in Northern Europe, Scandinavia, just inside the Arctic Circle, revealing scant

vegetation for reindeer to feed upon, and their habits of living.

An Informal Gathering of the Inhabitants.—A portion of the coast of the Antarctic Continent with abrupt, icy walls, icebergs, and floating ice, and a stretch of open water in the center. The only forms of life in this desolate, intensely cold region are penguins, seals and skua gulls. The model shows the behavior of lower animals when their habitat has not been disturbed by man.

THE RETURN OF THE FISHERMEN—ONE OF THE FRANKLIN GEOGRAPHICAL MODELS.

The Return of the Fisherman.—A scene of one of the tropical islands in the South Pacific Ocean. The natives having speared several large fish are drawing their outrigger-dugout on to the beach in front of their flimsily built house.

The Kangaroo Hunt.—A part of the central Australian desert, inhabited chiefly by Red Kangaroos. The human beings are aborigines and the scene depicts two of them with their weapons hunting the kangaroo to obtain food.

Stalking the Monkeys.—A scene in the lowlands of the Brazilian Jungle, the home of the toucans, monkeys, sloths,

and tapirs as well as the Carib Indians. Bright rays of the tropical sun penetrate the dense vegetation of the forest where a native is shooting at a monkey with his blow gun.

Welcoming the Traveler.—An incident in the Sahara Desert, showing a Bedouin tent pitched near a water hole, Bedouins partaking of fresh dates gathered from the date palms, and a Berber traveler, just arrived, being given a gourd of water. The camel of the Bedouins is knee-haltered. An impression is given of intense tropical heat and glare.

A Resented Intrusion.—A village of the Masai, a British East African tribe. Just before sunrise a lion has leaped into the village and seized a sheep which had been brought in the night before. The men with spears and shields are advancing on the lion in a semi circle formation with the intention of killing it.

This scene represents a frequent occurrence in British East Africa.

The Quarry Brought Home.—A dreary region in southern Patagonia. The impression is given of cold clouds and strong west wind blowing. A tent is shown belonging to one of the families of the Tehuelches. The man of the family has returned from the hunt with a guanaco and a woman is examining the skin of the slain animal. In the toldo an old woman is sipping maté through a straw.

The Habitual Fighters.—On a high, narrow, rocky, windswept ledge in the mountains of Afghanistan, three Afridis are firing upon their peacefully disposed neighbors cultivating their fields.

As we have said, the models are the work of Mr. Dwight Franklin, a specialist in museum groups of this sort. Though himself an artist, he follows closely the scientific method, and in the preparation of the groups takes great pains to assure accuracy, calling in for consultation a number of authorities on the various fields covered. That he has been successful is shown by the approval of such authorities as the late Theodore Roosevelt, Dr. Frederick A. Lucas, Dr. William T. Hornaday, the late Admiral Peary, Anthony Fiala, and C. William Beebe. Further confirmation is given by the children themselves,

with whom the Geography Room is almost the most popular spot in the museum.

The following incident is given as an interesting illustration of the way a museum expands. Miss Gallup realizing that the model system would be the ideal way to teach Geography to children, one day explained her idea to a visitor, who responded by offering a gift of money to pay for the first group.

Dr. Lucas, director of the American Museum of Natural History, assured Miss Gallup that he knew the very man who should be engaged to make such models, Mr. Dwight Franklin of New York. Miss Gallup at once sought an interview with Mr. Franklin who was at that time working on educational models for the Museum in Newark, New Jersey.

A short talk with Mr. Franklin during which he roughly sketched a series of geographical models convinced Miss Gallup she had been wisely directed, and resulted in the ordering of the first models.

A short time afterward work on the first of them was begun, and it made such striking progress that before completion of the model the movement was under way which has resulted in the completed Geography Room, probably the most striking exhibit in the museum.

ARTS AND CRAFTS ROOM.

One room is devoted to the arts and crafts of countries, both in America and other continents. There are seven wall cases and one table case. The European case contains a number of fine Portuguese figurines, and there are other figurines in the one devoted to Mexico and Central America. The Polynesia case contains various articles of clothing and furniture and a model of an outrigger canoe. In the Asia case are wooden models of women weaving matting, coolies carrying bales of tea, a farmer plowing a rice field, a model of a typical Japanese house, and—by way of contrast—an alabaster model of the Taj Mahal at Agra.

The value of models in such a study as this is almost without limit. Thus at the University of Chicago there are not

only a number parallelling those of the Children's museum, but others showing various forms of looms and weaving, an European railway train, and, most successful of all, a large model of a Viking hall, equipped with furniture, weapons, and inhabitants carved from wood. There is also an abundance of actual specimens illustrating clothing, weapons, utensils and tools, and religious articles. Everything can be taken from the cases and transported to the school rooms where it is needed. The Children's Museum does not face this difficulty, since in most cases the exhibit room also is the study hall,—and here lies one of the chief advantages of the Museum. It is able both to bring the specimens to the children and the children to the specimens, while the average school museum or children's department of a large museum can do only the former because of unsuitable and insufficient space.

LOAN COLLECTIONS.

The original loan collections of the Museum consist of small, glass-fronted boxes that the children can carry about with them. The boxes contain birds, insects, shells, or minerals, as the case may be, and are given out to children who have earned the privilege by learning in the Museum a set number of specimens. They also are sent out to centers that seek to encourage the children in nature study, and to schools. At the museum the loans are filed on shelves in a large storeroom, where they may readily be found by any of the assistants.

The small cases, though thoroughly serviceable, are only partly satisfactory. There was need for larger exhibits, in larger cases, giving more complete presentations of natural history subjects than do the box loans. After study of the "Traveling Exhibits" such as are in use at the American Museum in New York, and the Field Museum of Chicago, Curator Gallup and her staff designed a similar case suited to the precise needs of the Children's Museum. There were some modifications; it was decided to use scenic backgrounds instead of plain ones neutrally tinted, and further study showed that these backgrounds were both more service-

able and more completely represented when done in oil colors by an artist. Tinted backgrounds made from enlarged photographs, such as are used in large exhibits at the Chicago Academy of Sciences, and in School Cases of the Field Museum of Natural History, are less costly than the ones done in oil, but they also are less durable.

It was decided that the traveling exhibit should be made a memorial to the man principally responsible for the development of the Children's Museum, thus bearing the title, "The Children's Museum Loan Collection, Franklin W. Hooper Memorial."

The artist in charge of the work, Mrs. Clara L. Parsons, has been very successful in her efforts. As in many other phases of museum exhibition, this is a place where technical skill alone is not sufficient; one must also be an artist. The preparation of a small group that is to appear life-like is even more difficult than that of a large one, since the space allowed for the development of the effect of distance is very slight. With animals living in underbrush or rocks this difficulty is not so great. But when one attempts to put, in a case measuring 7 by 18 inches, a male robin pulling an earthworm from the ground, his mate on the branch of an apple tree, against the background of a large orchard, the task is no small one. Mrs. Parson meets it successfully with good proportions of both accessories and background.

LIBRARY.

The library of the Children's Museum was opened to the public in April 1900, but its actual beginning antedates the institution of which it is a part. For it is a direct descendant of the first free library established in the city of Brooklyn.

More than a century ago, in 1823, a company of gentlemen established the "Brooklyn Apprentice's Library," which in 1843 became the "Youth's Free Library," extending its privileges to minors of both sexes. At that time prizes were awarded for the best essays on geography and natural history, and also for the most accurate mechanical drawings, submitted by the readers.

In 1887, the organization known as the Youth's Free Library was incorporated as the Brooklyn Institute of Arts and Sciences, and its collection of books became a general library, called the Brooklyn Institute Library. When the Children's Museum was established, the nucleus of its library was formed from a selection of The Youth's Free Library

GENERAL READING ROOM OF THE LIBRARY.

books (which had been stored in the building since the destruction by fire of the old building of the Institute), to which were added by purchase a few hundred new illustrated volumes adapted to the use of children and students. Since that time, additions have been made from month to month, so that the Museum now possesses a well-rounded library of about 10,000 volumes that is both up-to-date and adequate to meet most of the demands made upon it. Dr. Lucas once said it was

the "best natural history library in the country;" since that time it has grown more valuable.

The books, however, are not restricted to natural history, nor are they distinctly of the "nature study" type. They range from picture books and simple stories to scientific and technical manuals, and include a good collection of encyclopedias and dictionaries. Ninety current periodicals are received. All books are for reference use only, and are consulted by about 60,000 children yearly, with now and then an adult seeking information that he cannot get in a general library.

The value of selecting such a library as this makes it worth while to give a general summary of the books which it contains, with citations of a few of the more representative titles:

NATURAL SCIENCE.

Including Zoology, Botany, Physiology and Hygiene. It consists of studies of animal life, and illustrated field books for identifying birds, flowers, and trees. There are hand-books for teachers, books on conservation, forestry, and gardening, such as: "Encyclopedia of American Horticulture," and "Pictured Knowledge." Several complete sets of periodicals, such as "Bird Lore," "Country Life in America," "Nature Study Review," "The Nature Magazine," "Natural History," "The Guide to Nature," "American Forestry," and several complete sets of Entomological Magazine.

HISTORY AND BIOGRAPHY.

Stories of great leaders and heroes, discoverers and explorers. Classic legends, text-books and year-books, current history and present day topics. "History for Ready Reference," "Book of History," "National Cyclopedia of American Biography," *Magazines.* "Journal of American History," "Current History," "The World's Work," "The Survey."

GEOGRAPHY AND TRAVEL.

Commercial, descriptive, and physical geographies; books of travel, gazetteers and atlases. Sets of "National Geographic Magazine," "Journal of Geography," and "Asia."

APPLIED SCIENCES.

Astronomy, Experiments in Physics, Electricity and Chemistry. Practical books on Handicraft and Radio. Stories of Inventions, and their application to every-day life.

Magazines:—"Popular Mechanics," "Popular Science Monthly," "Scientific Monthly," "School Science and Mathematics," "Radio News," "Monthly Evening Sky Map."

LITERATURE.

Collections of poems, books of plays, and famous stories. "Library of the World's Best Literature," "Cumulative Book Index," "New International Encyclopedia," "Encyclopedia Britannica," "Encyclopedia Americana," "Compton's Pictured Encyclopedia."

EDUCATION.

History of Education, Psychology and Pedagogy. Supplementary Readers; Periodicals for teachers, such as "Popular Educator," "Primary Education," "Teachers Monographs," "Normal Instructor," and "Teachers College Record."

ART.

Architecture, Drawing, and Photography. Famous Painters, Sculptors, and Musicians. "Great Artists," "Dictionary of Music and Musicians." "Young Peoples Story of Music," "Story Lives of Great Musicians," "Cyclopedia of Painters and Painting," and "Picture Study in Elementary Schools." The monthly Bulletins of numerous art museums of America.

Personal help is given to readers who seek information of any kind, for example, Boy Scouts, Girl Scouts, Campfire Girls, and Woodcrafters, and members of similar organizations.

Stress is laid on two points—encouragement of the reading habit and teaching children how to obtain information from books. To foster the reading habit, cards are provided in the back of each book, on which are written the child's name and the number of the page where he stops reading. When the child comes again the place is quickly found and the story continued. Reading is coördinated with school work by means of

syllabi of courses of study, which are supplied by the Board of Education, and are followed by the Museum.

The reading room of the library is well suited to the display of picture bulletins. A wire partition between the reference room and the hall affords a place for posters dealing with new books. Several kinds of posters are used, with considerable success. There are always on exhibition nature pictures and bulletins dealing with birds, flowers aand trees. They are chosen for each season or event that demands new material and frequently changed. There are Bird Bulletins, and also cumulated monthly lists of birds seen in Prospect Park, which are provided by the Bird Lovers' Club of Brooklyn.

There are also patriotic bulletins commemorating significant dates, such as Washington's Birthday, Lincoln's Birthday, and Memorial Day, as well as bulletins with appropriate pictures and decorations for other holidays. Picture bulletins are devoted to scenes from foreign lands, or the childhood of famous people whose names and pictures may appear in poems, dealing with the appropriate person or country.

LECTURES—PUBLICATIONS.

A public lecture is given every week day except Monday and Saturday, at 4 P. M. On Saturdays lectures are given at 10:30 A. M. and 2:30 P. M. These have proved so popular that the small lecture room is quite inadequate for the audience that gathers.

It is, however, well equipped with a stereopticon and motion picture machine. Often a lecture must be repeated, occasionally several times, when six or seven hundred wish to hear the same talk. If some children have walked several miles and others have come long distances on the cars, to disappoint them would be to defeat the object of their visit and the aim of the museum. The only thing to do it to repeat the lecture until everyone is satisfied.

The lectures are illustrated with both colored and plain lantern slides, motion pictures, apparatus, and experiments. Special lectures may be given by arrangement with the Museum. Frequently teachers ask for subjects which will be

helpful in connection with their school work. Officers of the Board of Education coöperate by permitting, and even encouraging the principals of schools to send children to the museum during school hours for special lectures.

Since nature study is required by the Board of Education, the Museum talks on nature parallel their schedule. The lecture programs are prepared a month in advance and copies of the program are mailed to all public and private schools in Brooklyn where they are posted on bulletin boards. They are also published in the daily newspapers. The following is an example for a month:

Grades 7A or 7B		Domestic Science	Tuesdays, 4:00 P. M.
January	8	The Water Supply of New York City	
	15	The Story of Rice and Sugar	
	22	Milk from Dairy to Farm	
	29	Animal Productions for City People	
Grades 5A or 5B		American History	Wednesdays, 4:00 P. M.
January	9	Growth and Progress of the United States of America	
	16	The War with Our Mexican Neighbors	
	23	The Civil War (Part I.)	
	30	The Civil War (Part II.)	
Grades 8A or 8B		Physics	Thursdays, 4:00 P. M.
January	3	The Single Cell	
	10	Chemical Actions in a Cell	
	17	Different Kinds of Cells and their Uses	
	24	The Galvanometer	
	31	Induction	
Grades 6A or 6B		Motion Pictures	Fridays, 4:00 P. M.
January	4	Making Shoes (Part I.)	
	11	Making Shoes (Part II.)	
	18	The Salmon Industry	
	25	No Lecture	
For all Grades		Foreign Travel	Saturdays, 10:30 A. M.
January	5	A Mediterranean Cruise	
	12	The Egypt of Yesterday and To-day	
	19	A visit to the African Jungle	
	26	A Trip to Japan	
Primary Grades			Saturdays, 2:30 P. M.
January	5	The Footwear of Foreign Children	
	12	Bird Life of the Polar Regions	
	19	Plant Life of the Zones	
	26	The Silk Industry	

The lectures also supplement and enhance the interest in the collections. Frequently after a lecture the children go to one of the rooms to examine a model which by means of the talk has acquired some new meaning, or they go to the library to read on subjects suggested by the pictures illustrating the talk. Always the lecturer seeks to show children how they may apply in every-day life the facts which they learn in the museum at school. The popularity of the lectures is attested by the fact that in a single month as many as 5,700 children attend them, and that in one month alone eighty special lectures were given.

A collection of about five thousand lantern slides, a well selected film library, and a large number of photographs of museum specimens are conveniently filed, and requests for a special lecture can be answered on short notice.

Case talks given by members of the staff are certain to attract a crowd of children. Objects in the exhibit collections are explained, and the useful is combined with the interesting. Thus the instructor shows by means of specimens the difference between useful and harmful hawks, or by both specimens and models, the distinction between poisonous snakes and harmless ones. It is interesting to speculate what the result would be for the country if the children in every town of the land had a chance to learn these simple facts. Away would go the mythical "chicken hawk" and the wicked "hoot owl", and perhaps even the bull snake would be allowed to go about his business of eating mice.

Games have been devised for each of the exhibitions, and are played in the exihbit rooms. Each child is given a card bearing a detailed question which may be answered either by inspecting an exhibit pertaining to the question or reading the label. The children vie with each other in answering the questions quickly and correctly.

The value of these games is proved in a number of ways. The child obtains a wealth of information by becoming thoroughly familiar with the specimens and exhibits: his powers of observation are greatly stimulated, and he is entertained in a beneficial way during his spare time.

The children apply the knowledge gained in this way in

their class rooms with startling appropriateness. In fact it has been said museum children are noticeably brighter in their school work.

Volunteers offer their services to tell stories at Woodcraft Councils or remain in an Exhibit-room for an afternoon when they can play the games with the children or give informal educational talks.

One winter a volunteer gave a series of talks once a week in the History Room on historic Brooklyn. During the week the children in a group visited places of historic interest relevant to the talk and brought to the next meeting most delightful and original reports on things seen and done on their trips. If a doubt arose as to the correctness of some historical point, the child would go to the library to verify the statement.

In the spring a student of old New York and Brooklyn was invited to the Museum to give a lecture. The announcement of this talk brought so many children that the lecture room was crowded beyond its capacity. Children sat on window sills, stood in the aisles, and in the door leading to the porch. Their quickness and eagerness to answer questions asked was astonishing to anyone who was not familiar with the Museum children. When, later in the afternoon, the lecturer was about to leave and was being thanked for his kindness in coming to the Museum he said with much enthusiasm: "Don't thank me. I thank you for letting me know there is such a place as the Children's Museum."

A publication of a Monthly paper "The Children's Museum News" is a means of communication with the general public, especially with the schools. The paper is sent not only to every public and private school in Brooklyn, but to Museums and libraries in this country and abroad.

THE CHILDREN'S MUSEUM LEAGUE.

The Children's Museum League is the children's own organization. The members elect their own officers, and conduct meetings according to parliamentary rules, with occasional advice from a museum instructor. Meetings are held weekly, and programs are prepared at least a week in advance. Talks

are given on museum collections and activities, and on discoveries made on field trips. Even discussions of school topics are brought before the League's open forum. Thus the child learns by free discussion to present a subject in a concise, interesting manner, for no one will stay through a meeting that becomes dull.

Membership costs but ten cents, and so excludes no one. The child receives a membership badge and certificate on which is printed the motto:

"Tell others about the Museum."

and the pledge:

"I promise to wear the League badge, to visit the Museum, to interest others in the museum, and to get new members for the League."

A simple program this, but one that, when faithfully carried out, results in a tremendous extension of the Museum's influence. The child who attends meetings takes an interest in them, and the one who gets new members is anxious to assure himself that the organization to which he belongs has something to offer.

The League member who learns forty insects (ten moths, ten butterflies, ten beetles, and ten straight-winged insects) is entitled to borrow from the Museum a butterfly net. He may keep it a whole summer, using it while making his collection of insects. Specimens are brought to the Museum and the child is taught to spread the wings, mount, and label them. A little girl of six in one summer prepared seventy-five butterflies. The collection was so good that her teacher asked her to bring it to school and show it to the class. Another girl has on exhibition a collection of over five hundred insects, begun when she was nine and finished when twelve. All are correctly identified and labeled.

In the study of minerals a child may borrow a tray containing twenty labeled specimens and a geologist's hammer to use in collecting.

The Museum offers courses of work and study for individual children to follow. These courses are made short and easy for young children, but are graded into more difficult tests until they cover several months. A certificate of credit

COLLECTING BUTTERFLIES ON A FIELD TRIP.

is given on completion of each course. Many work hard for the honor of being presented with a certificate at a meeting of the Children's Museum League. The Library is an important factor in working for tests, for looking up references, and making notes and drawings.

The courses may be chosen in any order and are as follows:

Subjects	Value in Credits
Animal Study	20
Aquarium Study	10
Insect Study	15
Bird Study	15
Mineral Study	10
Botany	10
History	10
Geography	10

These eight subjects presented by the Museum collections may be combined in any way. When 50 credits are earned a bronze medal is given to the child in recognition of the achievement.

THE TREE CLUB.

Another active Museum organization bears the formidable title of "Tree Club of the American Association for the Planting and Preservation of City Trees." With its headquarters at the Museum, the Tree Club has chapters throughout the Borough of Brooklyn, and a total membership of about 20,000 children. Anyone from the very young to the child of high school age is eligible, and even adults have joined.

The club has been in existence about twelve years, and in that time has planted many hundreds of trees along Brooklyn's streets, in school yards, and about churches, libraries, and other public institutions. The largest single enterprise undertaken by it is a stretch of six blocks on Albany Avenue, each of which has eighteen sycamores or pin oak trees—more than a hundred trees in all. Funds for tree planting are raised by sale of old newspapers, tinfoil, old rubber, and metal. These are brought to the Museum and stored away in a cellar provided by the Park Department until enough have been collected to sell. The enterprise is fun for the children,

LEARNING TO MOUNT INSECTS.

and substantial results. A drayload of newspapers brings a hundred dollar contribution to the tree fund.

During the summer the children who are at home spend many of their vocation hours collecting egg masses of the Tussock moth. Many thousands of these, each capable of producing about five hundred voracious caterpillars, have been collected by the Tree Club members and burned in the Museum furnace. Not only is the immediate benefit from this destruction of great importance; the lesson of conservation taught by it is even more significant.

THE TREE CLUB SELLS A LOAD OF NEWSPAPERS.

Study out of doors begins in May. The new member can start his work at the very door of the Museum, for there are forty species of trees in Bedford Park alone, and each of them is labeled. Later on trips are made to other parks, to the suburbs, and even into the country, and collections of leaves are made as records of the things seen.

In autumn lectures are given on the life histories of the trees of Long Island and elsewhere. The colored slides show the trees as they appear in summer and in winter; their flowers and fruit, and detailed views of their bark. This is the

same information which colleges and normal schools give to their classes in nature study, though generally with equipment far poorer than that used by the Children's Museum. And so far as can be seen, the children take to the subject quite as readily and as successfully as do the college students. Many a sophomore has found that the museum training gave him knowledge that was only partly and hastily learned by his friends who were training to be teachers in grade and high schools.

Members of the Tree Club who have done specially good work are eligible to the rank of Tree Warden, and at the Saturday morning meetings of the club they report on their work for the week, and assist the others in tree study. They take a real interest in their work, and urge other children to respect the rights of the trees which the city and the League have planted. Thus they materially reduce the vandalism so harmful in a city even more than in a small town.

FIELD TRIPS.

Field excursions are held both in connection with the work of the tree club, and with various other branches of nature study carried on by the Museum. They are conducted under the guidance of a special field instructor during the late spring and summer months.

Groups of children who have shared in the Museum's activities are taken, whether they are members of its associations or not. They visit parks, fields, woods, and seashores—wherever there are the natural materials for nature study. Those interested in insects carry nets, poison jars, and boxes; the bird students have field glasses and notebooks, while those interested in geology and mineralogy have geologists' hammers and collecting bags. Still others carry tin vascula in which to take back flowers. Careful notes are taken on the trips. On their return the youngsters go to the Busy Bee Room for the pressing of their plants, the sorting and identification of minerals, and the mounting of insects on spreading boards. Caterpillars that have been taken are put in the breeding cage, where they may be fed until the time of pupation.

THE WOODCRAFT LEAGUE, GIRL SCOUTS, BOY SCOUTS.

The program of the Woodcraft League of America is particularly suited to the use of the Museum's materials, and several councils of this national organization have been formed. There are tribes for older boys, older girls, and younger boys and younger girls, as well as one for adults who are interested in the work. Meetings are held in the Woodcraft Room, whose walls are decorated with Woodcraft totems. At one end of the room are the Council seats, arranged about the fire; at the other is a series of shelves which are used for the bird houses, lanterns, and other objects made by the Woodcrafters as their tests.

Seed pods, pressed plants, minerals, and other nature materials are brought to the room by members of the tribes. There is a work bench provided with tools, and a good hospitable cook stove that is used on special occasions for the preparation of tribal feasts. The closets are stocked with a complete service of china, glass, and silver for use at such times. The room has other uses as well, for in it children coming to the Museum for a day may eat the box lunches which they bring with them, and luncheons and teas are served to groups of people who are working with or for the Museum.

The Museum also is the headquarters for the nature work among the Boy Scouts and Girl Scouts of Brooklyn, and on Saturday mornings they come to it to prepare for the tests which constantly are being given in their organizations. Work with them is curtailed because of insufficient space.

The girls, however, take their second class nature tests under Museum direction, using Museum material. To do the work more thoroughly, the Museum established a branch museum in the Brooklyn Girl Scout Camp on the shore of Lower Twin Lake, New York. A museum instructor who had worked with the girls through the winter months was detailed to carry on this work in camp. By this means more than four hundred girls who had begun nature work in the museum

during the winter were able to continue it in camp in the summer.

This small camp museum has become a model for those used by Girl Scout organizations in other camps throughout the country, and the movement inaugurated by it promises to add materially to the success of the national conservation program in future years. A girl Scout Museum Nature Club, started at the request of the girls who worked in the museum and camp during 1923, is continuing the interest aroused.

SUMMARY OF RESULTS.

During the twenty-four and a half years of its existence the Children's Museum has achieved what may be justly called notable results. We may summarize these as follows:

1.—It has increased its exhibits from a few models, charts, and specimens, to thousands of items and groups displayed in two corridors and twelve rooms, as well as in extensive collections designed only for circulation to children and institutions.

2.—It has carried on extensive educational and conservation work through lectures, trips, games, and the activities of several juvenile organizations.

3.—It has aroused the people of Brooklyn, particularly through the Woman's Auxiliary, to the importance of museum work, properly conducted by a separate children's museum, in the life of a community.

4.—It has produced actual results among the children with whom it has worked. This is shown by numerous conversations and letters in which men and women testify as to the importance of the Museum in directing their early interests; also in estimates by educators and others of the activities and work of "museum children."

5.—It has served as the forerunner of a large number of children's museums, both in this country and Europe. Among these may be mentioned the children's departments in the new National Museum at Cardiff, Wales, and the Geological Museum of Yale University; the Children's Museum of the Cleveland Museum of Arts, and the children's museums of Boston and Cambridge. These last were developed as direct results of the work of the Brooklyn Children's Museum, and organized on lines adapted from it. In many schools and normal schools the museum departments have either been planned after the Children's Museum, or on lines suggested by it.

Finally, we have the opinion of several museum experts, such as Laurence Vail Coleman, secretary of the American

Association of Museums, and others. Some of the estimates are worth quoting, not only because they indicate the success of the Children's Museum, but because they emphasize the significance of the entire movement in which it was pioneer:

I am confident that the Brooklyn Children's Museum and the Children's Museum at Jamaica Plain are two of the most useful institutions in the country, and I think it is unfortunate that there are not many more museums of the same character scattered over the country. I believe that if all science and art museums could have connected with them *children's museums*, which would develop in the children a love and understanding for the objects in the larger museum, it would be, perhaps, the greatest factor in developing supporters and users of the adult museum.

FREDERICK ALLEN WHITING, *Director*,
The Cleveland Museum of Art, Cleveland, Ohio.

My own regret, in connection with the children's museum idea movement is, that we are not ourselves provided with sufficient space to give adequate room for this branch of our work. I would like nothing better than a situation such as you have, where we could devote a whole building to the children and give special attention to children's exhibits and instruction.

I sincerely trust that there will come a day when every city, not only of the first class, but even minor cities, will possess a good, live children's museum.

S. A. BARRETT, *Director*.
Public Museum of the City of Milwaukee, Milwaukee, Wisconsin.

If I were given the alternative of establishing a recreational and scientific museum or a children's museum, modeled on the lines of your excellent institution, I would feel that the funds were put to the better use in supporting the children's museum.

As a matter of fact, if it were possible to begin at the beginning, I would rather establish a children's museum first and expect the development of the larger museum to grow from it, for in that way the community would raise up its friends of the museum movement in its own school of entertainment and instruction. They would be the best type of citizens, capable of appreciating and understanding the objects and the purpose of museums.

WILLIAM ALANSON BRYAN, *Director*.
Los Angeles Museum of History, Science and Art.

And finally, this forcible statement by a musician who also is an educator, written in the Children's Museum on January 8, 1924:

"The Children's Museum does universally for children just what I

have always urged people to do for them in music. It gives them the best and nothing but the best. Most parents have the idea that a cigar-box violin is good enough for little Johnnie to learn on. When he is accomplished, they say, he can have a better fiddle. What folly! Johnnie will have troubles enough without the added handicap of poor tools. A Stradivarius is none too good for him. If you must give anybody a cigar-box give it to Kreisler. He could get music out of a shredded wheat biscuit. But let us always take our cue from the Children's Museum and give the children the best we have."

ROBERT HAVEN SCHAUFFLER.

NOTE:—*This periodical is indebted to Mrs. Anna C. Montgomery and Miss Anna Billings Gallup for information concerning the Children's Museum, and to Miss Gallup for permission to use the numerous cuts belonging to the Museum.*

The Native Flora of the Vicinity of Cold Spring Harbor, N. Y.*

SCHIZOPHYTA, MYXOMYCETES, DINOFLAGELLATAE, BACILLARIOPHYTA.

N. M. GRIER.

While this contribution is intended to serve primarily as a check list for the use of students and botanical research workers at the Biological Laboratory, Cold Spring Harbor, New York, it will also serve to acquaint others who may be interested with the rich flora of the vicinity of the Laboratory, and indicate opportunities for its further study.

Since assuming charge of the course in Field and Systematic Botany at the Laboratory, the writer and assistants have been engaged in making a card catalogue of the native and cultivated plants in the vicinity of the Laboratory as these were collected by members of the staff and students. He has also examined and assembled records left by former workers at the Laboratory and from the foregoing and all other available records in the literature dealing with the Flora of Long Island—including all those species apt to be encountered by members of the Laboratory in the field—has compiled the following list. All who collect in the vicinity of Cold Spring Harbor in the future are requested to send their records to the Director of the Laboratory in order that the knowledge of the local flora be as complete as possible. The workers whose data besides that of the writer is represented in this list are:

Professor L. N. Johnson, University of Michigan—L. N. J.

Professor D. S. Johnson, Johns Hopkins University.—D. S. J.

Mrs. Mary Lentz Johnson—M. L. J.

Dr. H. H. York, New York State Conservation Commission, Albany, N. Y.—H. H. Y.

---

* Contribution No. 8 from the Biological Laboratory, Cold Spring Harbor, N. Y.

Dr. G. C. Fisher, American Museum of Natural History.—G. C. F.

Professor L. D. Swingle, University of Utah.—L. D. S.

Professor W. E. Maneval, University of Missouri.—W. E. M.

Dr. A. F. Blakeslee, Carnegie Institution, Cold Spring Harbor, N. Y. —A. F. B.

Professor H. S. Conard, Grinnell College.—H. S. C.

Professor E. N. Transeau, Ohio State University.—E. N. T.

Professor J. Arthur Harris, University of Minnesota.—J. A. H.

Miss Miriam Bomhard, University of Pittsburgh.—J. A. H.

Miss Charlotte Easton, University of Chicago.—C. E.

Miss Gail Holliday, Wheeling High School.—G. H. H.

Professor Susan A. Green, Maryville College.—S. A. G.

Miss Betty Watt, Carnegie Institution, Cold Spring Harbor, N. Y. —B. W.

Professor John W. Harshberger of the University of Pennsylvania and Professor O. E. Jennings of the University of Pittsburgh have contributed through the verification of records. Others who kindly aided in revising certain portions of the manuscript group are cited in connection with their particular service.

"Die Natürliche Pflanzenfamilien" of Engler and Prantl and the "Syllabus der Pflanzenfamilien" of these authors, (1919) form the back ground of the taxonomy and nomenclature used in the cryptogamic groups exclusive of the Pteridophyta, although the specialists revising these have been given full sway, authoritative works being cited. In the Pteridophyta and all higher groups the arrangement is essentially that of Britton and Brown's "Illustrated Flora of the Northern States and Canada," edition of 1913.

I.—SCHIZOPHYTA.

SCHIZOMYCETES.

Here Jelliffe* includes common pathogenic and saphro-

* Jelliffe, S. E. "The Flora of Long Island" published by the author 64 W. 56th St. N. Y. City, N. Y. Also "Additions to the Recorded Flora of Long Island" Torreya 4. Hereafter reference to these papers will be to the name of this author, with whom, however, were associated other collectors in compiling the records.

phytic bacteria and lists also the following as not being infrequent.

BACTERIACEAE.

Pseudomonas pyocyanea (Gessard) Migula.

Pseudomonas violaceus (Schroeter) Migula.

Pseudomonas fluorescens (Fluegge) Migula.

PHYCOBACTERIACEAE.

Cladothrix dichotoma Cohn. In water.—Jelliffe.

BEGGIATOACEAE.

Beggiatoa alba Trev. Frequent on Long Island.—Jelliffe.

Beggiatoa mirabilis Cohn. On stalks and stones in inner harbor.—D. S. J.; H. H. Y.

SCHIZOPHYCEAE †

CHAMAESIPHONACEAE.

Chamaesiphon SP. Epiphytic on *Cladophora* sp.—D. S. J.

CHROOCOCCACEAE.

Calothrix confervicola Ag. On *Cladophora* tide pools. Lloyd's Point, L. I.—M. L. J.

Calothrix crustacea (Schousb.) Bar. and Thur. On grasses and algae at Eatons Point, L. I.—N. M. G.

Calothrix parasitica (Chauvin) Thuret. Common on *Nemalion*.—C. S. H.; D. S. J.

Calothrix pulvinata Agardh.—C. S. H. Growing on tufts of *Spartina patens*.—D. S. J.

Calothrix scopulorum (Web and Mohr.) Ag.—C. S. H. On posts under old mill.—D. S. J.

Clathrocystis rosea—persicina Cohn. Salt creeks, Laurelton pier.—D. S. J.

† This group is revised following the terminology given in "Minnesota Algae." Vol. I. Report of Survey, Botanical Series VIII., Professor Josephine Tilden, U. of Minnesota.

Chröococcus turgidus (Kütz) Naeg. On *Spartina* stubble inner harbor.—C. S. H., D. S. J. and H. H. Y.

Coelosphaerium Kutzingianum Naeg. Frequent.—Jelliffe.

Dactylococopsis rhaphidivides Hans. Common in Jarvis pond.—C. S. H.; N. M. G.

Gloiotrichia natans. Thur.—C. S. H. On submerged plants and sticks in 1st lake.—M. L. J.

Merismopaedia glauca Naeg. Not infrequent.—Jelliffe.

NOSTOCACEAE.

Anabaena torulosa Carm.—C. S. H. On mud among *Spartina* stalks.—D. S. J.; H. H. Y.

We are able to confirm Burnham and Latham's record for this plant.* (*Torreya*, 14.)

Anabaena variabilis Kuetz. West side inner Cold Spring Harbor.—D. S. J.

Cylindrospermum majus Kuetz. Bottom of Jarvis Pond.—C. H. S.; N. M. G.

Nostoc Sp. Inner Harbor.—C. S. H.; D. S. J.

Spaerozyga carmichaeli (Harv.) Estuary north of cement bridge.—C. S. H.; H. H. Y.

Sphaerozyga polysperma Kuetz. Vicinity Cold Spring Harbor.—H. H. Y.

Sphaerozyga thuretii Cru. Vicinity Cold Spring Harbor.—D. S. J.

OSCILLATORIACEAE.

Lyngbya aeruginea caerulea Kuetz. Frequent on Long Island.—Jelliffe.

Lyngbya aestuarii Ag. Pools in the salt meadows.—C. S. H.; N. M. G.

Lyngbya confervoides C. Agardh.—C. S. H. On mud in outlet from hatchery ponds.—D. S. J.

Lyngbya luteofusca (Ag.) J. Ag. Research wharf, Cold Spring Harbor.—D. S. J.

Lyngbya nigrescens Harv. Not infrequent along coast.—Jelliffe.

Lyngbya semiplana J. Ag.—C. S. H. Mud and tangles about *Spartina*.—D. S. J.; H. H. Y.

Microcoleus sp. Old pier, Cold Spring Harbor.—D. S. J.

Microcoleus chthonoplastes Thuret.—C. S. H. On mud between *Spartina* stems.—D. S. J.

Microcoleus tenerrimus Desmaz. Algal mats on marsh.—C. S. H., D. S. J. and H. H. Y.

Oscillataria Sp. Seven incompletely identified species of this genus are found among the algal felts in Cold Spring Harbor.—D. S. J.

Phormidium laminosum (Agardh) Gom. Jarvis pond.—C. S. H.; M. L. J.

Oscillatoria animalis Agardh. Forming mats in first lake.—C. S. H.; D. S. J.

Oscillatoria formosa Bory.—C. S. H. Floating in water in trout pool.—L. D. S.

Oscillatoria gracilima Vauch. Common in Jarvis pound.—C. S. H.; N. M. G.

Oscillatoria limosa Agarth. In mats of other *Oscillatoria* sp. —D. S. J.

Oscillatoria ornata Kuetz? Forming brightest green mats in

Oscillatoria ornata Kuetz? Forming bright green mats in

Spirulina subsala Oersted.—C. S. H. On *Zostera* in inner harbor.—H. H. Y.

Spirulina thuretii Con. Laurelton Pier.—H. H. Y.

RIVULARIACEAE.

Isactis plana (Harvey) Thuret. Algal Felts on Marsh.—C. S. H. Inner Harbor.—D. S. J.; H. H. Y.

Rivularia atra Roth. East band of estuary.—C.S.H.; H. H. Y.

Rivularia Sp. Inner Harbor.—C. S. H.; D. S. J.

Rivularia Nitida Agardh. North and east Shore Cold Spring Harbor.—D. S. J.

II.—MYXOMYCETES.*

CERATOMYXACEAE.

Ceratiomyxa fructiculosa (Muell.) Macbr. On Moss.—C. S. H.; M. L. B.

Ceratiomyxa poriodes (Alb. and Schw.) Schroeter. On stump near falls second lake.—C. S. H.; D. S. J.

CLATHROPTYCHIACEAE.

Dictidium cancellatum (Batsch) Macbr. Abundant on Wood.—C. S. H.; D. S. J.

Enteridium splendens Morg. On rotten wood west of 1st lake.—D. S. J.

CRIBRARIACEAE.

Cribraria aurantiaca Schrad.—C. S. H. On rotten wood near first lake.—D. S. J.

Cribraria languescens Rex.—C. S. H. On rotten wood—hills west of 1st lake.—D. S. J.

---

*Revised following the terminology given in "North American Slime Molds," (new and revised edition.) T. H. MacBride, MacMillan and Company, 1922. See also papers by Burnham and Latham, *loc. cit.* and "Contribution to the Recorded Fungus and Slime Mould Flora of Long Island." Reichling, G. A., Torreya, 5.

Cribraria microcarpa Pers.—C. S. H. On rotten wood of 1st lake.—D. S. J.

Cribraria minutissima Schwein.—C. S. H. On rotten wood. Hills west of 1st lake.—D. S. J.

Cribraria piriformis Schrad. On decaying log 1st lake.—C. S. H.; D. S. J.

Cribraria tenella Schrad.—Jelliffe.

DICTYOSTELIACEAE.

Dictyostelium mucoroides Brefeld. On muskrat dung.—D. S. J.

DIDYMIACEAE.

Chondrioderma spumarioides (Fries.) C. S. H. On dead leaves near 1st lake.—D. S. J.

Diderma testaceum (Schrad.) Rost.—C. S. H. On dead leaves near 1st lake.—D. S. J.

Diderma effusum (Schw.) var. reticulatum Rost. On L. I. —Jelliffe.

Didymium melanospermum (Pers.) Macbr. At head of 1st lake.—C. S. H.; D. S. J.

Didymium nigripes (Link.) Fries. Frequent on dead leaves. —C. S. H.; D. S. J.

Didymium squamulosum (Alb. and Schw.) Frjes. On dead leaves at head 1st lake.—C. S. H.; D. S. J.

LICEACEAE.

Tubulina ferruginosa (Batsch) Mac. B. Abundant on wood —C. S. H.; D. S. J.

PHYSARACEAE.

Badhamia decipiens (Cort.) Berk. On dead oak leaves.—C. S. H.; West of 2nd lake.—G. C. F.

Badhamia lilacina (Fr.) Rost. On growing herbs near 3rd lake.—C. S. H.; D. S. J.

Badhamia rubiginosa (Chev.) Rost. On L. I.—Jelliffe.

Fuligo septica (Linn.) Gmel. On rotten log.—C. S. H.; M. L.

Leocarpus fragilis (Dickson) Rost. Link. Occasional on mosses, dead leaves in vicinity of school house.—C. S. H.; D. S. J.

Physarum globuliferum (Bull.) Pers. Occasional on wood.—C. S. H.; D. S. J.

Physarum leucopus Link. On leaves at 1st lake.—C. S. H.; D. S. J.

Physarum nodulosum Cke and Balf. On dead leaves near first lake.—C. S. H.; D. S. J.

Physarum nucleatum Rex. On Long Island.—Jelliffe.

Physarum sinuosum (Bull.) Weinm. Frequent on wood, leaves and moss.—C. S. H.; D. S. J.

Physarum tenerum Rex. Woods west of 1st lake.—C. S. H.; D. S. J.

Physarum virescens Difm. On moss near 1st lake.—C. S. H.; D. S. J.

Physarum viride (Bull.) Pers. On rotten sticks near 1st lake.—C. S. H.; D. S. J.

PLASMODIOPHORACEAE.

Hemitrichia clavata (Pers.) Rostf. Frequent on wood.—C. S. H.; D. S. J.

Hemitricha vesparium (Batch.) Macbr. Common on wood.—C. S. H.; D. S. J.

Hemitrichia stipitata (Mass.) Macbr. On rotten wood.—C. S. H.; G. C. F.

RETICULARIACEAE.

Reticularia lycoperdon (Bull.) Rost. On tree neear men's dormitory.—C. S. H.; D. S. J.

Tubifera ferruginosa (Batsch) Macbr.—C. S. H. On old stumps near Blackford hall.—M. L. B.

STEMONITACEAE.

Comatricha caespitosa Sturgis.—Jelliffe.

Comatricha longa Peck. On rotten wood.—C. S. H.; D. S. J.

Comatricha lurida List. On L. Island.—Jelliffe.

Comatricha nigra. (Pers.) Schroeter. On wood west of 1st lake.—C. S. H.; D. S. J.

Comatricha typhoides (Bull.) Rost.—C. S. H. On old logs in lake region.—M. L. B.

Diachea elegans Fries. On Long Island.—Jelliffe.

Enerthenema papillatum (Pers.) Rost.—C. S. H. On rotten wood west of 1st lake.—D. S. J.

Lamproderma arcyrionema Rost. On rotten wood.—C. S. H.; D. S. J.

Stemonitis fusca (Roth.) Rost. Abundant on wood.—C. H. S.; D. S. J.

Stemonitis pallida Wingate. On old wood.—C. S. H.; D. S. J.

Stemonitis smithii Macbr.—C. S. H. On rotten wood by 1st lake.—N. M. G.

Stemonitis splendens Rost.—C. S. H. On rotten wood in swamp by lakes.—M. L. J.

TRICHIACEAE.

Arcyria ferruginea Sauter.—C. S. H. On rotten wood, hill west of 1st lake.—D. S. J.

Arcyria denudata (Linn.) Sheldon. Very common on wood.—C. S. H.; D. S. J.

Arcyria incarnata (Pers.) Macbr. On rotten wood.—C. S. H.; M. L. B.

Arcyria nutans (Bull.) Grev. On rotten wood west of 1st lake —C. S. H.; D. S. J.

Hemiarcyria clavata (Pers.) Rost. Woods west of 1st lake. C. S. H.; N. M. G.

Hemiarcyria rubiformus (Pers.) Rost. Cold Spring Harbor vicinity.—D. S. J.

Lachnobolus globosus (Schw.) Rost. Frequent on rotten wood.—C. S. H.; D. S. J.

Lycogola epidendrum. (Buxb.) Av. In old woods, south side Long Island.—M. L. B.

Trichia persimilis Karst. Occasional on wood.—D. S. J.

V.—BACILLARIOPHYTA, (*Diatoms*)*

ACHNANTHOIDEAE.

Cocconeis pediculus Ehrb. Frequent throughout island.—Jelliffe.

Cocconeis scutellum Ehrb. On *Zostera* in Inner Harbor.—C. S. H.; D. S. J.

DISCOIDEAE

Gaillonella nummuloides (Dilw.) Bory. On *Zostera* in Inner Harbor.—C. S. H., D. S. J. and H. H. Y.

Lysigonium moniliforme (Muell.) Link. On *Zostera* in Inner Harbor.—C. S. H., D. S. J. and H. H. Y.

Meloseira granulata (Ehrb.) Kuetz. Fossil.—C. S. H.; D. S. J.

FRAGILAROIDEAE.

Asterionella formosa (Hass.) Fr. Frequent throughout island. —Jelliffe.

Diatoma hiemale (Lyngb.) Heiberg. Frequent Long Island. —Jelliffe.

Diatoma vulgare Bory. Common in second lake.—C. S. H.; N. M. G.

Eunotia lunaris (Ehrb.) Grün. Frequent throughout Long Island.—Jelliffe.

Fragillaria capucina Desmaz. Common throughout the island. —Jelliffe.

Fragilaria virescens Ralfs. Common in second lake.—C. S. H.; N. M. G.

Synedra offinis Kuetz. On *Zostera* Inner Harbor.—C. S. H.; D. S. J. and H. H. Y.

Synedra pulchella (Ralfs.) Kuetz. Common throughout the Island.—Jelliffe.

Synedra radians Kuetz. In second lake.—C. S. H. Common. —N. M. G.

Synedra ulna (Nitsch) Ehrb. Second lake.—C. S. H. Common.—N. M. G.

Rhabdonema Adriaticum Kuetz. Not infrequent throughout coast.—Jelliffe.

Tabellaria fenestrata Kuetz. Frequent in fresh water.—Jelliffe.

Tabellaria flocculosa (Roth) Kuetz. Second lake.—C. S. H. Common.—N. M. G.

NAVICULOIDEAE.

Amphipleura sp. On *Zostera* Inner Harbor.—C.S.H.; N.M.G.

Amphora ovalis (Breb.) Kuetz. Frequent.—Jelliffe.

Gomphonema constrictum Ehrb. Common in second lake.— C. S. H.; D. S. J.

Navicula virdis Kuetz. Frequent throughout island.—Jelliffe.

Pleurosigma angulatum (Quek) Cl. Mud, pebbles, etc.—C. S. H.; D. S. J.

Neidium affine (Ehr.) Pfitzer. Common in second lake.—C. S. H.; D. S. J.

Navicula cuspidata Kuetz. Common throughout island.—Jelliffe.

Navicula grevillei (Ag.) Cl. On *Zostera* Inner Harbor.—C. S. H.; N. M. G.

Navicula Kennedyi W. Sm. On *Zostera* Inner Harbor.—C. S. H.; H. H. Y.

Navicula Lyra Ehrb. Not infrequent around coast.—Jelliffe.

Navicula major Kuetz. Common in second Lake.—C. S. H.; D. S. J.

Gyrosigma Balticum (Ehr.) Cl. Not infrequent in salt marshes, throughout island.—Jelliffe.

Pleurosigma distortum W. Sm. Mud, pebbles, etc.—C. S. H.; D. S. J.

SURIRELLOIDEAE

Surirella elegans Ehrb. Not infrequent throughout island.—Jelliffe.

---

* Revised according to Van Huerck's "Treatise on the Diatomaceae" with some reference to "The Diatomaceae of Philadelphia and Vicinity." —C. S. Boyer, Philadelphia, 1916. J. B. Lippincott Company.

(To be Continued.)

Dartmouth College,
Hanover, N. H.

The American Midland Naturalist

PUBLISHED BI-MONTHLY BY THE UNIVERSITY
OF NOTRE DAME, NOTRE DAME, INDIANA

VOL. IX. JANUARY, 1925. NO. 7

Botanical Gleanings in Michigan.

II.

OLIVER ATKINS FARWELL.

Our collecting trips during 1924 were somewhat handicapped by frequent rains, and getting soaked was a frequent occurrence, though not in a way to offend the 18th Amendment. I have frequently read in scientific papers that it is an acknowledged fact that there is a tide on the Great Lakes. I had never observed it until our visit to Monroe Piers, August 27th. We arrived at about 9 o'clock A. M. The beach at that time of the morning was bare of water for about two hundred yards out and was anything but prepossessing as a bathing beach; we wondered where the bathing beach was. When we came back at about 1 o'clock P. M., there were about a thousand children in bathing where four hours earlier the beach had been dry sand!!! There probably was all of eight inches of water on the beach which would necessitate a tide of about a foot in depth. The water had not been blown off shore in the morning because at that time there was a perfect calm; it was not blown in at 1 o'clock because what wind there was at that time was off shore. While the above remarks are not strictly of a botanical nature, the incident that calls them forth is so full of interest that the opportunity to put it on record cannot be resisted. A similar tide was observed in St. Clair River at Walpole Island, September 3rd following. We arrived at Walpole Island before the Customs Office had been opened for the day and not knowing it was necessary to get permits to botanize on Squirrel Island, which is an Indian reservation, we went along without securing them

and thus placed ourselves subject to arrest as we were told by a good looking and good natured young Indian who was engaged in hauling in new made hay. We were not interfered with, however, and made some interesting finds, at least to us. On the shores of Walpole Island we found the following:

Polygonum Lapathifolium var. *Salicifolium,* No. 7094d and *P. littorale,* No. 7091a; *Stellaria graminea,* No. 7125, a luxuriant form with an inflorescence over 3 dm. in length; *Aster paniculatus* var. *cinerascens,* No. 7128, also on Squirrel Island, No. 7112; *Artemisia Pontica,* No. 7129, in flower, the first time we have found it in this condition, though it is well distributed and encountered every year; *Senecio vulgaris,* No. 7089. On Squirrel Island the more interesting plants are: *Unisema cordata* f. *angustifolia,* No. 7118; *Triorchis gracilis,* No. 7109, with either 1, 2, or 3 roots; *Lithospermum Gmelini,* No. 7121; *Aureolaria Skinneriana,* var. *asperula,* No. 7115, and its forma *pallida,* Nos. 7116 and 7098; the plant previously reported as *A teniflora* var. *Gattingeri,* No. 5675, is *A. Skinneriana* var. *asperula; Lacinaria scariosa* vars. *aspera,* No. 7113, and *sphaeroidea,* No. 7114, are plentiful and each variety has the involucral scales passing by degrees from pure white to rose; *L. spicata,* No. 7113a, is plentiful but ints forma *albiflora,* No. 7102, is scarce; a variation of *L. spicata* with a shortened and thickened spike not over one dm. in length and with each enlarged head subtended by a foliaceous bract, two to four times its length may be known as *Lacinaria spicata* (Linn) OK. var. *foliacea,* n. var. 7103.

Botrychium dissectum, Spreng. and var. *elongatum* (Gilb. & Harb.) Farwell. Much has been written about these two forms of the Grape Fern relative to their association in the field. On May 7, 1924, while botanizing just over the State boundary line in Ohio, a number of fronds of the preceding year were discovered in good condition, upright and with no sign of disintegration, proving them to have been evergreen, or semi-evergreen. Both forms were found scattered here and there in the copse. But two plants, one of each form,

were intertwined and gave the appearance of springing from the same root. Careful digging showed them to be quite distinct; the roots of *B. dissectum* were directly over those of the var. *elongatum* which were 22 mm. deeper down in the soil than those of the former. While not appertaining strictly to the Flora of Michigan, yet on account of the nearness of the habitat to Michigan, this paper seems to be an appropriate place to make a record of a closeness of association that seems worthy of note.

Another interesting find here, which is near Alexis, O., is an albino form of *Cardamine Douglassii* (Torr.) Britton which may be known as *C. Douglassii* f. *albidula*, n. f. Flowers white or some with faint tinge of color. Although this species is abundant here and in Michigan, I have never before seen an albino form. It is not rare here. This species in this general region flowers a month earlier than the related *C. bulbosa*. No. 6880a, May 7th.

The dry hills near Orion were sparsely covered with dwarfed vegetation; as interesting specimens of this nature, we collected plants of *Lepidium Virginicum* and of *Veronica arvensis* that were less than a cm. in height yet in full flower and with the lower fruits fully matured.

At Andrew's Lake, Oct. 22, we found that the water in the leaves of Pitcher Plants was frozen; the ice was of varying thicknesses, the heaviest being about one-half inch thick.

Where the year is not given, it is to be understood that Farwell and Gladewitz are the collectors for the year, 1924.

Botrychium dissectum, Spr. var. *obliquum* (Muhl.) Clute. This variety is rather scarce in southeastern Michigan, rarer even than the typical form of the species; the most frequent form being var. *enlogatum*. Algonac, No. 7260, October 15th.

Hippochaete Nelsoni (A. A. Eaton) Farwell. Sterile stems of this species, smoothish to the touch, were found near Oxford on upland pastures. No. 7209, Sept. 24th.

Potamogeton foliosus, Raf., var. *Niagarensis* (Tuckm.) Morong. This is the coarsest form of the species with

broad leaves and flat stems as broad, or nearly so, as the leaves (1.5 mm.) found in swiftly running water. Clinton R. west of Rochester, No. 6974, July 16th.

Digitaria linearis (Linn.) Pers. Said to be common in Michigan, but I do not find it so. Waste grounds near Redford,, No. 7245, Oct, 8th.

Panicum flexile (Gattinger) Scribn. This species of Panic Grass is not at all common in southern Michigan and where it is found it may be very scarce or very abundant as at the Powell Lake region; No. 7215, Sept. 24th. On Walpole Island in St. Clair River, (Canada) where it is very scarce. No. 7122, Sept. 3rd.

Panicum clandestinum, Linn. Roadsides near Algonac. At this time of the year, all the fruits had fallen from the panicles. No. 7257, Oct. 15th.

Echinochloa Crus-galli (Linn.) Beauv. var. *hispida* (Muhl.) n. comb. *Panicum Crus-galli* var. *hispidum* (Muhl.) Ell. Bot. S. C. & Ga. I (1816) 114. Spikelets with long, purplish awns and the lower leaves with hispid sheaths. Shores of Lake Erie at Monroe Piers; in yellow sand, No. 7075, Aug. 27th. I have collected this previously at Detroit where it was plentiful along the shores of Detroit River; in mucky grounds, No. 1679, Sept. 13, 1900.

Echinochloa Crus-galli var. *hispida* subvar. *laevigata* (Wiegand) n. comb. *E. Walteri* forma *laevigata* Wiegand, Rhodora XXIII (1921) 62. This differs from the variety in having the sheaths glabrous. Shores of Detroit River on Belle Isle. In marshy grounds, No. 1881-½, Sept. 23, 1904. This variety differs from other variations of the species in having the upper glume terminated by a short purplish awn; but the upper glume in forma *longiseta* (Belle Isle, No. 1881, Sept. 15, 1904) is very long acuminate or very shortly awned, a transition connecting this variety with the species.

Chaetochloa glauca (Linn) Scribn. This species frequently has a very slender spike, 3 to 6 cm. long and 7 mm. wide exclusive of the bristles which are short, being less than

twice the length of the spikelets many of which are of a purplish color; the brlstles also are purplish in the upper half in the living state but are liable to lose this color in drying. It is this form (No. 6467) that I reported in an earlier paper as *C. imberbis*... It has also been collected at LaSalle, No. 7167, Sept. 17th; Redford, No. 7246, Oct. 8th; and at Bloomfield, No 7278, Oct. 19th.

Chaetochloa viridis (L.) Scribn. var. *minor* (Koch) Farwell. This variety has purplish bristles and some of the flowers may have the same color. Geddes, No. 7058, Aug. 20, 1924.

Chaetochloa Italica (L.) Scribn. var. *Germanica* (Roth) Farwell f. *Metzgeri* (Koern.) Farwell. Roadsides at Geddes, No. 7059, Aug. 20, 1924.

Zizania aquatica, Linn. Indian Rice or Water Oats. In a recent paper on this genus in *Rhodora,* Mr. Fasset says in giving its distribution: "Inland in northern New York, and rarely in Michigan." and quotes New Buffalo as its Michigan locality; this town is in the southwest corner of the State on Lake Michigan. It can be found by acres in the marsh lands of the eastern coast of Michigan from St. Clair River to Lake Erie. It has been found in Washtenaw Co., and I doubt not that it occurs throughout the southern tiers of counties. Monroe Piers, No. 7077, Aug. 27th. I have colected it previously as follows: Shores of Belle Isle in the Detriot River, No. 1297, Aug. 12, 1892; Grosse Ile in Detroit River, No. 1297a, Aug. 14, 1909; Shores of the Huron River at Geddes, No. 1297b, Aug. 21, 1909.

Zizania aquatica var. *agustifolia,* Hitchcock. A narrow leaved variety, low as a rule, but it may attain a height of 2 meters. This variety is rare in southeastern Michigan. Squirrel Island in St. Clair R., (Canada), No. 7120, Sept. 3rd. I have collected it in Michigan as follows: Shores of the Huron River at Geddes, No. 2115, Aug. 21, 1909; Marl Lake, No. 4372, Aug. 13, 1916.

Oryzopsis pungens (Torr.) Hitchc. Found on dry sandy or sterile grounds near Orion; this is the typical form of the species wherein the florets are awnless. No. 6903, June 4th.

Triplasis purpurea (Walt.) Chapm. This plant looks very much like a rather stiff *Sporobolus vaginaefolius*. It dries out more or less purplish but is green in the living state except the terminal panicle which is purple, and partly included in its sheath; the lateral panicles are all included. A book name is Sand Grass. Shores at Monroe Piers, No. 7076, Aug. 27th.

Festuca octoflora. Walt.. This annual, slender species of Fescue-grass is very rare in southeastern Michigan. In my wanderings through nine counties over many years, I have found it but once or swice heretofore. A small patch of it was found in sand near Erie. No. 7000, July 30th.

Eragrostis pectinacea (Mx.) Steudl. On a sandy field near Wayne, No. 7156, Sept. 10, 1924.

Secale Cereale, Linn., var. monstrossa, Koern. This variety of Rye has a compound spike, that is, with 3 or 4 branches near the base each 2-4 cm. in length. Erie, No. 6987, July 30th. Both Bearded and Beardless Wheat and Oats were growing here adventitiously and in abundance over an extensive piece of wild land.

Eleocharis rostellata, Torr. Borders of Powell Lake near Oxford. The shores of this lake are of marl; parts of the lake are submerged and in places the overlying surface is very thin and shaky. No. 7202, Sept. 24th.

Elymus Canadensis, Linn, var. *robustus* (Scribn. & Sm.) Farwell. I have seen this variety for the first time in Michigan, this year (1924). In the typical form the spikes are large, dense, not interrupted, and mostly more or less included and the lemmas are sparsely strigose; but those characters are variable and pass into those of the common form here, the var. *Philadelphicus*, but can always be differentiated by the large spikes. Along the railway right of way in dry grounds near Denton. No. 7131, Sept. 10, 1924. In similar situations at Geddes, No. 7057, and at Ann Arbor, No. 7042, Aug. 20, 1924. The collections at Geddes and at Ann Arbor are intermediate but are placed here on account of their robust spikes. The lemmas usually are 3-awned,

the two lateral awns being short and closely appressed to the terminal awn and so are rather inconspicuous.

Cyperus erythrorhizos, Muhl. Shores of Cass Lake, rare; No. 7220, Oct. 1st.

Eriophorum vaginatum, Linn, var. *humile,* F. Nylander. In a sphagnum bog near Orion. This quite extensive bog gave rise to not more than half a dozen clumps of this Cotton Grass; but last autumn it was literally filled with the *E. Virginicum* var. *album.* No. 6896, June 4th.

Eriophorum Virginicum, Linn. In the sphagnum overgrowth of a submerged lake—Andrews Lake. No. 4400, Aug. 22, 1916; Lakeville, No. 5319, July 20, 1919. The var. *album,* A., Gr. we found at Andrews Lake this year. No. 7287, Oct. 22nd.

Carex sparganioides, Muhl. var. *lutea,* Farwell. In open, dry woodlands at LaSalle; culms stiff, over a meter high; perigynia yellow. No. 7189, Sept. 17th.

Carex alopecoidea, Tuckerm. A new station for this Carex was discovered, this time in Oakland Co., west of Rochester in low grounds along the railroad; No. 6958, July 9th. We had collected this species previously in Wayne Co. at Gibraltar, No. 6156, May 31, 1922, and at Trenton, No. 5771, May 26, 1921; in Monroe Co. at South Rockwood, No. 5872, June 14, 1921.

Carex alopecoidea, Tuckerm., var. *sparsispicata,* Dew. This var. with fewer flowered, more remote spikes is scarce. We collected it in Monroe Co. at Newport, No. 6241, July 5, 1922.

Peltandra Virginica (L.) Knuth forma *hastifolia,* Blake. This is the commoner form of the species in Michigan. In shallow water, Geddes, No. 7051, Aug. 20, 1924.

Junkus tenuis, Willd. var. *uniflorus,* Farwell. A rare variation of the species with but one flower. Mt. Clemens, No. 7022, Aug. 14, 1924. Redford, No. 7242, Oct. 8th.

Juncus Dudleyi, Wieg. In sandy soil at Algonac. Frequent. No. 7270, Oct. 15th.

Juncus brachycephalus (Engelm.) Buchn. Marl shores of Powell Lake, scarce; No. 7203, Sept. 24th.

Juncus Torreyi, Coville, var. *globularis*, Farwell. In dry, sandy grounds near Wayne. No. 7140, Sept. 10th, 1924.

Juncus alpinus, Vill. var. *fuscescens*, Fernald. Shores of Cass Lake, scarce; No. 7218, Oct. 1st.

Juncus marginatus, Rostk. Rare in southeastern Michigan, this being the first time detected. In sand and only a few specimens noticed—less than a dozen. Erie, No. 6990, July 30th. Associated with *J. acuminatus*, Mx., No. 6991 and *J. tenuis*, Willd., No. 6992.

Lilium superbum, Linn. Differs from *L. Michiganense* in its somewhat broader leaves, which are perfectly smooth to the touch, at least in the living state and without any sign of scabrousity even under a strong lens. After taken from the press, a re-examination showed under a lens a minutely rough margin and some scabrousity on some of the nerves of the lower leaves; the upper ones, however, were as soomth as in the living state; to the touch the margins of the lower leaves felt slightly rough but the veins did not. No difference could be detected in the flowers, either in the color, which ranged from orange-yellow to deep red, or in the degree of recurvation of the segments, or in their spots. Erie, No. 6989, July 30th; Parkedale, No. 7015, Aug. 7th.

Trillium erectum, L. var. *Cahnae*, n. var. This is a variation intermediate in coloration of the flower between the species and the var. *album*. The basal ¼ section of the petals on the upper surface is brownish-purple as in the species, the upper parts being of a very pale purplish white to dull white, the lower surface being mottled with pale purplish brown and green. The stamens are 10 or 12 mm. long, the anthers twice as long as the filaments, which with the ocnnectives, are full purple as is the ovary. Collected in the vicinity of Clawson, Mich., by Mrs. Cahn of Highland Park, Mich., May 17, 1924. Rather plentiful. Mrs. Cahn also found good specimens of the variety *album* (Mx.) Ph. and needless to say of the typical form of the species, also.

Triorchis cernua (L.) Nieuwl. var. *ochroleuca* (Rydb.) n. comb. Flowers greenish or faintly yellowish, some white,

with longer floral bracts than usual in the species; it was found in very dry fields near Wayne, No. 7152 and near Sheldon, No. 7137, Sept. 10, 1924. LaSalle, No. 7190, Sept. 17th; Algonac, No. 7274, Oct. 15th.

Triorchis Romanzofiana (Cham.) Nieuwl. On the shores of Davis Lake. Rare. No. 7211, Sept. 24th.

Salix alba X fragilis, Wimmer. Flowering specimense of the tree reported last year as the var. *calva* indicate it to be this hybrid. A re-examination of the old mature leaves, this time with a lens, showed the presence of some very fine appressed silky pubescence. The twigs are very brittle and break at the base at the slightest pressure, suggesting *S. fragilis;* but the leaves and young branchlets are pubescent suggesting *S. alba.* The mature, more or less pubescent leaves are the narrow leaves of *S. alba* but with the few coarse serratures of *S. fragilis.* It may be the hybrid *S. alba X fragilis* as suggested last year, but it certainly is not the var. *calva* as reported.

Salix serissima (Bailey) Fernald. The Autumn Willow was found at the Powell Lake region in excellent fruiting condition. Rare; No. 7216, Sept. 24th; Waterford, No. 7283, Oct. 22nd.

Humulus Japonicus, Sieb. & Zucc. In roadside ditches at Wayne. No. 7159, Sept. 10, 1924.

Castanea dentata (Marsh.) Borkh. Known to occur in southeast Michigan only. North of Monroe, *Gladewitz & Farwell,* No. 5829, July 6, 1921; Ecorse, No. 6917, June 11, 1924. The tree at Ecorse was not yet in flower.

Polygonum Fowleri, Robinson. Prostrate or rarely ascending. Differs from *P. aviculare* in having the upper part of the achene exserted. Previously reported as *P. Rayi.* Detroit, No. 7006, Aug. 7th; Mt. Clemens, No. 7018, Aug. 14, 1924.

Cycloloma Atriplicifolium (Spreng.) Coult. This species is slowly but surely spreading widely. Ypsilanti, No. 7060. Aug. 20, 1924. It is well established on Walpole Island in St. Clair River (Canada), No. 7095a, where we collected it Sept. 3rd.

Amaranthus hybridus, Linn. This species was found in sand near Redford. Its peculiarity in this location was its short, thick, rounded spikes, 4 to 6 cm. long by 1.5 to 2 cm. thick. The spikes were not flexious, yet they were not as stiff as those of *A. retroflexus.* No. 7247, Oct. 8th.

Anychia Canadensis (L.) B. S. P. On sandy grounds in dry woodlands. Erie, No. 6999, July 30th; No. 7180, LaSalle, Sept. 17th.

Silene dichotoma, Ehrh. This Catchfly is rapidly spreading over Oakland Co. Orion, No. 6980, July 23, 1924.

Saponaria officinalis, L. var. *Caucasica,* Bailey. The double flowered, Rosy Bouncing Bet was frequent along fence rows near Wayne. No. 7134, Sept. 10, 1924. The typical form of the species is abundant everywhere. The pale double flowered form, var. *florepleno* is also found occasionally.

Nymphozanthus variegatus (Engelm.) Fernald. In the Clinton River at Cass Lake. Frequent. No. 7223, Oct. 1st.

Anemone Virginiana, Linn. var. *leucosepala,* Fernald. This variety looks much like *A. riparia* Fernald but it differs in having obovate petaloid sepals instead of oval ones and anthers 1.2 to 1.5 mm. long while those of *A. riparia* are 1 mm. or less. With the typical form of the species. Banks and fields west of Rochester, No. 6960, July 16th.

Anemone riparia, Fernald. Rather scarce; occurs here and there on railroad banks and wooded hillsides in the Clinton River basin east of Rochester over a range of 2 or 3 miles. No. 7008, Aug. 7th.

Liriodendron Tulipifera, Linn. Found in St. Clair Co., north and west of Algonac; rare. No. 7276, Oct. 15th.

Radicula palustris (L.) Moench. Yellow Cress. Common in wet places. Keweenaw Co., No. 143, July 20, 1884; Ypsilanti, No. 143aa, June 21, 1892; Belle Isle, No. 143b, July 16, 1892; Mt. Clemens, No. 7020, Aug. 14, 1924. I have observed it in every county I have been through. *R. palustris* var. *hispida* (Desv.) Robinson. Often larger and coarser but much less frequent than the species though found in the same general habitat. Keweenaw Co., No. 144, July 20,

1884; Belle Isle, No. 144a, July 16, 1892; Frazer, No. 7033, Aug. 14, 1924.

Hesperis matronalis, L. f. *albiflora* (DC.) n. comb. *Hesperis matronalis* L., var. *albiflora* Dc. Prodr. I [1824) 189. Flowers white. Since this is only a color variation of the type, it should be ranked as a form rather than as a variety. Amy, No. 6976, July 16. Reported previously from Ypsilanti as var. *albiflora.*

Hirschfeldia, Moench. Meth. (1794) 264. *Ecrucastrum* Presl. *Fl. Sic.* I (1826) 92.

H. Gallicum (Willd.) n. comb. *Sisymbrium Gallicum* Willd., *Enum. Hort. Berol.* (1809) 678. *Erucastrum Pollichii,* Schimp. & Spenn. Fl. Freiburg. III (1829) 946. *H. Pollichii* Fritsch, *Mitteil. Naturw. V. Wien,* V (1907) 92.

Engler and Prantl in *Die Natur. Pflanzen.* III 2, 176, 177, maintain this genus of Cruciferae as distinct from *Brassica* but adopt the later name *Erucastrum* instead of the older name of Moench.

In so far as my knowledge goes, the proper combination under *Hirschfeldia* has not been made previously. I have collected it at the following places this year (1924); Mt. Clemens, No. 7031, Aug. 14th; Geddes, No. 7055, Aug. 20th; Ypsilanti, No. 7064, Aug. 20th.

Cakile edentula (Bigel.) Hook. var. *lacustris,* Fernald. The Sea Rocket is frequent on the shores of Lake Erie in Monroe Co. The processes and corresponding cavities in the articulating joints as pointed out by Prof. Fernald are quite characteristic. No. 2185, Aug. 20, 1910 and several times since. Squirrel Island in St. Clair River (Canada), No. 5684, Sept. 16, 1920; Longport, N. J., No. 5536a, July 3, 1920 and 5900a, June 27, 1921. Also at Longport, N. J., the typical form of the species with smoothish surfaces to the articulating joints was found; No. 5537, July 1, 1920 and No. 5901, June 27, 1921 and on Staten Island, No. 4029, Sept. 8, 1915. The leaves are much the same in both varieties: fleshy, the upper dentate, the teeth increasing in size on the lower leaves, the lowermost being pinnatifid.

Sedum aocre, Linn. It is doubtful if there is a cemetery in the state in which this species has not been planted and from which it has not escaped to contiguous lands. It was found in a pasture near Rochester fully a mile from the cemetery, far from any residence, and in land that had never been cultivated. Being as far as it is from residences of both living and dead, it seems to be somewhat out of place but apparently it is permanently established. No. 6971, July 16th. On the shores of Walpole Island in St. Clair River (Canada) it has established itself and under the influence of abundant water, it has become twice as large as the normal size for it in its usual dry situations. Specimens transplanted to dry ground have sent out a new growth of normal size. No. 7082, Sept. 3rd.

Sedum Telephium, Linn. var. *Fabaria* (Koch) Steudel. Quite common in Michigan but seldom seen in flower. Tuberous rooted. Specimens collected and planted, after being 2 weeks in press with 200 pounds pressure, are thriving. Near Denton, No. 7132, Sept. 10, 1924; also Keweenaw Co., No. 190, Aug. 22, 1884, and Port Huron, No. 4967, June 23, 1918.

Ribes Huronense, Rydb. Much like *R. Cynosbati* L. but the calyx is more slender and the style is divided. Ecorse, No. 6912, June 11, 1924.

Rosa Woodsii, Lindl. Along the railroad banks near Erie. One of the rarer roses in Michigan. No. 6988, July 30th.

Crataegus Almorum, C. S. Sarg. Fields and roadsides near Sylvan Lake, No. 7282, Oct. 22nd.

Crataegus albicans, Ashe (*C. Tatnalliana Sarg.*) It is some years since I have seen or collected this species and heretofore it has always been in Wayne Co. It has now been collected from Oakland Co. Near Yates, No. 6941, July 2nd.

C. Acerifolia, Moench. *C. mollis* Scheele. Rare in Michigan. Borders of streams or near water. LaSalle, No. 7166, Sept. 17th.

Prunus pumila, Linn. A low spreading shrub on sandy grounds. Orion, No. 6904, June 4th and fruit July 23rd. Leaves usually oblanceolate and acute.

Prunus cuneata, Raf. An upright shrub in similar situations. Orion, No. 6905, June 4th and fruit July 23rd. Leaves usually spatulate-oblong and obtuse.

Lupinus perennis, L., var. *occidentalis,* Wats. Differs from the type in having more villous stems and petioles. With the type but scarce. Orion, No. 6898, June 4th.

Lupinus perennis, L., f. *albiracemus,* A. H. Moore. This is distinguished by its white flowered racemes. Scarce. Orion, No. 6897, June 4th.

Meibomia Illinoenses (A. Gr.) O. K. Frequent near Ann Arbor and Geddes. The pubescence on all parts of this species is of hooked hairs and any part of it will adhere tenaciously to whatever it comes in contact with. Banks along the railroad right of way; No. 7047, Aug. 20, 1924. At LaSalle in Monroe Co., No. 7187, Sept. 17th.

Lespedeza Nuttallii, Darl. Roadsides near Cass Lake; scarce. No. 7233, Oct. 1st.

Vicia Cracca, Linn. The plants reported last year on a poor autumnal state as *V. sparsifolia* Nutt. prove to be of this species. Also found it at Pontiac; No. 6968, July 9th.

Geranium Robertianum, Linn. A drawfed state found on the high and dry hills or banks on the north side of the Clinton R. near Yates. No. 6942, July 2nd.

Polygala Senega, Linn. var. *latifolia,* T. & G. This rare variety was discovered in a new locality; it was observed on the right of way of the Grand Trunk Western, west of Rochester, occuring occasionally over a stretch of 5 or 6 miles. Amy, No. 6963, July 9th.

Polygala verticillata, Linn. Slender and inconspicuous. Usually in dry fields. Near Erie, No. 7005, July 30th. I have previously collected it as follows:—Detroit, No. 1436, Sept. 1, 1893; Rochester, No. 1436a, July 4, 1896 and No. 3856, Sept. 7, 1914; Parkedale, No. 3817, Aug. 9, 1914; and at Birmingham, No. 1436b, Sept. 6, 1903.

Polygala verticillata, var. *ambigua* (Nutt.) Wood. Reported as *P. ambigua* in the preceding paper from Avon township, Oakland Co.; I collected it at Rochester, a different part of the same township some years earlier. No. 3858, Sept. 7, 1914. This is better treated as a variety of *P. verticillata* than as a distinct species. Annual, though treated in Gray's New Manual as a perenial or biennial. Near Oxford, No. 7200, Sept. 24th.

Ricinus communis, Linn. The Castor Oil Plant is common in cultivation and frequently escapes to waste places. I have collected it as follows as an escape to waste grounds. Detroit, No. 1476, Aug. 4, 1894; near Mt. Clemens, No. 7028, Aug. 14, 1924.

Euphorbia dentata, Mx. Rare in this section of the country. Sandy shores of Lake Erie at Monroe Piers, No. 7068, Aug. 27th.

Sida hermaphrodita (L.) Rusby. Along the railway right of way near Wayne where it is frequent. No. 7145, Sept. 10, 1924.

Ludwigia alternifolia, Linn. This species with tuberous roots is abundant in low grounds on the border of a swamp west of Erie. No. 7001, July 30th.

Gaura coccinea, Pursh. This species was reported from White Pigeon by Dr. Beal. We found it east of Rochester. No. 7017, Aug. 7th.

Lythrum Salicaria, Linn. A meter or less in height, branched, glabrous; leaves alternate, opposite and whorled on the stem, opposite on the branches, ciliate, otherwise glabrous; calyx sparsely hispid, green to dark purplish; petals dark purple. Occasional in roadside ditches. Denton, No. 7139, Sept. 10, 1924.

Lythrum Salicaria var. *tomentosum* (Mill.) DC. The whole plant tomentose and tthe flowers pale purple. Similar situations. Occasional. Detroit, No. 4404, Aug. 27, 1916. Reported previously as *L. Salicaria*.

Uraspermum aristatum (Thumb.) OK., Rev. Gen. Pl. (1891) 270. *Chaerophyllum aristatum* Thunb., Fl. Jap.

(1784) 119; *Myrrhis Claytoni* Mx., Fl. Bor. Am. I (1803) 170; *Uraspermum Claytoni* (Mx.) Nutt., Gen. I (1818) 193; *Osmorhiza longistylis* (Torr.) DC. Prodr. IV (1830) 232. It is customary to refer the species of Michaux to *O. brevistylis* DC. and the species of Nuttall to *O. longistylis* DC.; but how this can be done consistently is beyond my understanding in view of the fact that Nuttall was merely renaming Michaux's genus and species. Nuttall's description shows clearly that he had the long-styled species and Michaux's phrase, "Folia absque canitie pubentia" can apply to no other, certainly not to *O. brevistylis*. The index Keweensis refers *Ch. aristatum* Thunb. to *O. Claytoni* and that to *O. brevistylis*. But Thunburg's description is of a plant with a smooth, grabrous, striate stem and fruit with aristate, divaricate styles, clearly the *O. longistylis*. It is evident, therefore, that all three authors, Thunburg, Michaux and Nuttall, named and described the same long-styled species and that their plant names are synonymous. This species is common in southwestern Michigan but not as abundant as the next. The var. *villecaule* (Fernald) Farwell was collected in Ecorse township west of Oakwood, Wayne Co., which makes another known station for this variety in Michigan. No. 6918, June 11, 1924.

Uraspermum dulce (Muhl.) n. comb. *Scandix dulcis* Muhl. Cat. (1813) 31. *Uraspermum hirsutum* Bigel. Fl. Bost. Ed. 2, (1824) 112. *Osmoshiza (sic) dulcis Raf.* Med. Fl. II (1830) 249. *Osmorhiza brevistylis* DC. Prodr. IV. (1830) 232. The specific name *dulcis* is the oldest name for this species and should be reinstated. Common and abundant in southeastern Michigan.

Uraspermum dulce var. *laevicaule*, n. var. Stems below the branches glabrous from the beginning, more thinly hirsute on the other parts than in the species. For several years I have observed a variation of this species that had a less dense pubescence and a stem glabrous up to the first branch and frequently up to the second. It is not by any means as common as the more hirsute type, but has been observed in a number of localities. Detroit, No. 5256, June

21, 1919; Pontiac, No. 5267, June 29, 1919; Pittsfield, No. 6208, June 28, 1922; Ecorse, No. 6921, June 11, 1924.

Coriandrum sativum, Linn. It has been some years since this was found on waste grounds in Detroit, but again it has been collected. No. 6984, July 25, 1924.

Anethum gravolens, Linn. Another station for the Dill has been discovered. It was found along the grassy border of a foot path. Amy, No. 6977, July 16th. Still another, this time at Detroit along the sides of unpaved streets. No. 7034, Aug. 15, 1924; also at Detroit, No. 5398, Oct. 15, 1919.

Andromeda glaucophylla, Link. In the sphagnum borders of Andrews Lake. Rare. No. 7288, Oct. 22nd. Also at Walled Lake, No. 4479, June 5, 1917; Pontiac, No. 4221, June 18, 1916; and Eagle Harbor, No. 6626, June 29, 1923.

Samolus floribundus, HBK. In a ditch near Wayne with Ludwigia & Proserpinaca. No. 7147, Sept. 10, 1924.

Bartonia Virginica (L.) BSP. Slender and inconspicucus. In moist, sandy woodlands. Rare. In the summer months the flowers are yellowish; but in the autumn months the flowers are more apt to be purplish. Near Erie, No. 6995, July 30th. Previously collected at Dearborn by *Billington and Farwell*, No. 5600a, Aug. 15, 1920 and by myself at Algonac, No. 4100d, Sept. 11, 1915.

Apocynum Farwellii, Greene. This species was found on railroad embankments where it was plentiful. Parkedale, No. 6938, July 2nd. Associated with it was var. *glaucum*, Farwell. The variety differs in being entirely glabrous and glaucous, and in having shorter, broader leaves which are ovate oblong. Parkdale, No. 6939, July 2nd.

Volvulus sepium, (L.) Junger var. *Americanus* (Sims) Farwell. Near Ann Arbor a very luxuriant form is found that has a second peduncled flower arizing from the axil of one of the bracts subtending the first flower. No. 7038, Aug. 20, 1924.

Volvulus spithamaeus (Linn.) n. comb. *Convolvulus spithamaeus* Linn. Sp. Pl. (1753) 158. *V. spithamineus* O. K. Rev. Gen. Pl. (1891) 447. Erect, usually branched, twining,

leaves deeply auricled and abruptly short acuminate, flowers in the axils of the middle leaves. Scarce in southerstern Michigan. Orion, No. 6930, June 25th and July 23, 1924.

Volvulus spithamaeus var. *stans.* (Mx.) n. comb. *Convolvulus stans* Mx. Fl. Bor. Am. I (1803) 136. Similar, but not twining, leaves shallowly auricled or rounded at base, flowers in the basal axils. Common in southeastern Michigan. Oxford, No. 6924, June 25th and July 23, 1924. In both of these varieties, the branches much exceed the short stems, as a rule.

Phlox subulata, L., f. *albiflora,* Britt. White pilose but slightly, if at all, glandular; corolla white, the deeply emarginate or obcordate lobes with two magenta lines at their bases. With the typical form of the species but scarce. Orion, No. 6902, June 4th.

Myosotis laxa, Lehm. Found in water in a swampy region; scarce. Parkedale, No. 6945, July 2nd.

Teucrium Menthifolium, Bicknell... Along the railway right of way near Wayne. No. 7157, Sept. 10, 1924. On Squirrel Island in St. Clair River (Canada), No. 7104, Sept. 3rd.

Isanthus brachiatus (L.) BSP. Called False Pennyroyal; abundant near Wayne, No. 7142, Sept. 10, 1924.

Mentha Cardiaca, Gerarde. Intermediate between *M. arvensis* and *M. viridis* with the odor of the latter. Monroe Piers, No. 7069, Aug. 27th.

Mentha gentilis, Linn. Odor somewhat similar to that of the Spearmint as in the preceding; it has larger floral leaves, yet these are small as compared with those of the next following. Parkedale, No. 7011, Aug. 7th; near Redford, No. 7248a, Oct. 8th.

Mentha arvensis, Linn. Good, typical forms of this species of Wild Mint have been found; it intergrades with its var. *Canadensis* and it is difficult to place some of the intermediate forms. The var. is by far the commoner form here. Parkedale, No. 7012, Aug. 7th; Monroe Piers, No. 7070, Aug. 27th, and at Washington, No. 8196, June 21, 1922.

Mentha arvensis var. *Canadensis* (L.) Briquet. Differs in having narrower leaves, acute at bsae. Parkedale, No. 7013, Aug. 7th. We also collected it at Washington, No. 6196a, June 21, 1922. I have collected it previously at Parkedale, No. 2910, July 28, 1912; in Keweenaw Co., No. 299, Aug. 1, 1885; and on Belle Isle, No. 299a, Aug. 13, 1892.

Mentha arvensis, Lim., var. *glabrata* (Benth.) Fernald. Found in the railroad yards in the southeast section of Pontiac; scarce. No. 6967, July 9th. I have collected it in Keweenaw Co., No. 300, Aug. 1, 1885.

Aureolaria purpurea (Linn.) Farwell. This species as it occurs in Michigan shows three definite sizes of the corolla: No. 1, from 22 to 28 mm. long; No. 2, from 16 to 20 mm. long; and No. 3, from 10 to 14 mm. long. The fruit is the same in all three forms, globular or nearly so and from 4 to 6 mm. in diameter. In No. 1 the calyx teeth are broader and less pointed than in No. 3, while No. 2 is intermediate. No. 1 is very rare in Michigan in so far as my observation goes, and No. 2 is always associated with it; No. 2 is common and is always associated with either No. 1 or with No. 3; No. 3 is by far the commonest and may or may not be associated with either No. 1 or No. 2. It seems better, therefore, to consider these series as varieties of but one species. No. 1 is typical *Aureolaria purpurea* (Linn.) Farwell. It has been collected at Orion. 908-½, Aug. 29, 1895; at Wayne, No. 7153, Sept. 10, 1924.

Aureolaria purpurea, var. *intermedia*, n. var. This is No. 2 with corollas from 16 to 20 mm. in length. *A. intermedia* (Porter) Farwell, partly. It has been collected at Wayne, Nos. 7159a and 7154, Sept. 10, 1924; LaSalle, Nos. 7161 and 7162, Sept. 17th; shores of Powell Lake, No. 7197, Sept. 24th; Detroit, No. 7239, Oct. 4, 1924.

Aureolaria purpurea var. *paupercula* (A. Gr.) n. comb. *Gerardia purpurea* v. *paupercula* A. Gr. Syn. Fl. N. Amer. II. 1. (1878) 293. Corollas from 10 to 14 mm. long. It has been collected at LaSalle, No. 7160, Sept. 17th; shores of Powell Lake, No. 7196, Sept. 24th; shores of Cass Lake, No.

7225, Oct. 1st; Walpole Island, No. 7123 and Squirrel Island, No. 7099, (Canada) Sept. 3rd; also at Walpole Island, No. 5677, Sept. 16, 1920; at Orion, No. 908, Aug. 29, 1895; Detroit, No. 4405, Aug. 27, 1916.

Aureolaria Skinneriana var. *asperula* (A. Gr.) Farwell. This variety was collected in dry sandy fields at Rochester. No. 3860, Sept. 7, 1914.

Plantago Rugelii, Dcne. var. *alterniflora,* Farwell. Scapes 10 to 20 cm. long with from 10 to 30 alterante flowers on the upper half, the lowermost separate, the upper slightly overlapping. Open woodlands near Redford; No. 7255, Oct. 8.

Grindelia squarrosa (Ph.) Dun. Fields near Oxford, No. 7195, Sept. 24th.

Solidago rugosa, Mill. var. *glabrata,* n. var. Stems *glabrous below the panicle* otherwise like typical *S. rugosa.* Moist alder thickets at Algonac;; No. 7273, Oct. 15th.

Solidago rugosa var. *laevicaulis,* n. var. Stems *glabrous below the panicle* otherwise like *S. rugosa* var. *villosa.* Moist woodlands; Algonac, No. 7272, Oct. 15th.

Solidago aspera, Ait. One of our common Goldenrods on open, dry grounds. Algonac, Nos. 7257a, 7258a, 7261, Oct. 15th.

Solidago aspera, Ait. var. axillaris, Farwell. With the species but rather scarce. Algonac, No. 7269, Oct. 15th.

Solidago graminifolia (Linn.) Salib. The Bushy Goldenrod in its typical form is not very frequent in southeastern Michigan. We have collected it as follows: Monroe Piers, No. 7071, Aug. 27th; Squirrel Island in St. Clair River (Canada) No. 7101, Sept. 3rd; Ypsilanti, No. 6327, Aug. 9, 1922; Orion, No. 6832, Sept. 26, 1923.

Solidago graminifolia var. *septentrionalis,* Fernald. This variety is the commoner form of the species on the Keweenaw Peninsula. The upper half of the involucral scales are green and the lateral branches conspicuously overtop the stem. Clifton, No. 484, Sept. 12, 1886 and Aug. 16, 1921.

Solidago graminifolia var. *Nuttallii* (Greene) Fernald.

This is the common form of the species in southeastern Michigan where it is abundant. Whole plant densely hirtellus. We have collected it as follows: LaSalle, Nos. 7171, 7172, 7173, Sept. 17th; Squirrel Island in St. Clair River (Canada) No. 7119, Sept. 3rd; Hamburg, No. 6757, Sept. 5, 1923; Oxford, No. 4769, Oct. 16, 1917; Junior, No. 4802-½, Oct. 28, 1917; Wayne, No. 7158, Sept. 10, 1924; Parkedale Farm, No. 3871, Sept. 7, 1914; Detroit, No. 484a, Aug. 31, 1892.

Solidago Gillmanni (A. Gr.) Steele. This Goldenrod was collected on Bois Blanc Island at the head of Lake Huron in August by Mr. and Mrs. F. W. Robinson of Detroit. They report it as quite plentiful there. This extends the known range eastward to the shores of Lake Huron, Mackinaw City being the point furtherest east previously reported.

Solidago neglecta, T. & G. var. *simulata,* Farwell. Borders of Powell Lake. No. 7207, Sept, 24th.

Aster azureus, Lindl., f. *incarnata,* n. f. Rays pink. Fields at Oxford. Occasional; No. 7191, Sept. 24th.

Aster Lowrieanus, Porter. The leaves underneath are sparsely pubescent. Dry, open woodlands at Cass Lake; No. 7227, Oct. 1st.

Aster sagittifolius, Willd. var. *urophyllus* (Lindl.) Burgess. Differs from the usual form of this variety in lacking the pilose pubescence on the under side of the leaves. It has the narrow inflorescence of this variety with the branches terminated by a thyrse-like raceme; rays white. In dry, open woodlands at Cass Lake; No. 7228, Oct. 1st.

Aster lateriflorus (Linn) Britt. var. *bifrons* (A. Gr.) Fernald. In dry, open woodlands at Cass Lake; No. 7229, Oct. 1st.

Erigeron ramosus (Walt.) BSP. var. *septentrionalis,* Fernald & Wiegand. (Var. *integrifolius* (Biegel.) Farwell.) In publishing this variety I had overlooked the earlier name of Fernald and Wiegand.

Erigeran Canadensis, Linn. var. *pusillus* (Nutt.) Barton. This variety as reported consists only of starved, depauper-

ate forms of the species and is not the *E. pusillus* Nutt. as redefined by Dr. Robinson.

Antennaria petaloidea, Fernald. Differs from *A. neglecta* in having a corymbiform inflorescence, that of the latter being racemiform. Ecorse, No. 6908, June 11, 1924.

Artemisia elatior, Linn. var. *heterophylla,* Farwell. Monoecious or dioecious, usually of low stature; lower leaves bipinnatifid, upper and those of the branches from entire to pinnatifid. Staminate spike often 12 mm. thick, the heads 4 to 6 mm. in diameter. In sandy fields near Redford, No. 7248, Oct. 8th.

Rudbeckia aspera, Pers. (*R. Sullivantii* Boynton and Beadle; *R. speciosa* var. *Sullivantii Robinson*). One of the plants or species called Yellow Daisy or Black-eyed Susan. In wet grounds. Scarce. Rochester, No. 2111, Aug. 15, 1909; Stony Creek, No. 3808, July 30, 1914; Parkedale, No. 4650, Sept. 27, 1917.

Helianthus annuus, Linn. Woodlands at LaSalle. No. 7183, Sept. 17th.

Helianthus lenticularis, Dougl. Railway right of way at at Wayne, No. 7155, Sept. 10, 1924.

Helianthus mollis Lam. Along fence rows in dry grounds near Wayne. No. 7136, Sept. 10, 1924. Only one station, Manistee, mentioned in the Michigan Flora.

Achillea asplenifolia, Vent. Along railroad embankments; scarce. Rochester, No. 6932, July 2nd.

Centaurea maculosa, Lam. On sterile or sandy grounds near Orion. No. 6978, July 23, 1924.

Hieracium scabrum, Mx. var. *tonsum,* Fernald. In thin woodlands. LaSalle, No. 7176, Sept. 17th. Associated with it were the typical form of the species, No. 7175; *H. subnudum* (Monn.) Froel. var. *folisum* (Mx.) Farwell, No. 7178; and var. *hirsutissium* (T. & G.) Farwell, No. 7177. The var. *hirsutissimum* differs from other variteies of *H. subnudum* in its longer, shaggy pubescence, the white hairs arising from purplish papillae.

Prenanthes alba, Linn, var. ovate, Farwell. Woodlands

at LaSalle. Leaves large, deltiod-ovate, denticulate. No. 7181, Sept. 17th.

ADDENDUM

Through the kind permission of Dr. J. A. Nieuwland of the University of Notre Dame, I am enabled to incorporate some very interesting finds which he has made while on various botonical excursions into Michigan.

Polypodium virginianum, Linn. Rogers Creek in Van Buren Co., Aug. 13, 1918. A new station for the Polypody in the Lower Peninsula.

Lycopodium inundatum, Linn. Muskegon Lake, Aug. 23, 1918.

Lycopodium clavatum, Linn var. *brevispicatum*. Peck. Spikes short (1.5 cm.) blunt, in pairs. The peduncles are 8 cm. long, intermediate between the typical forms of this variety and the species but the specimens seem to belong here rather than with the species. At Muskegon Lake, Aug. 24, 1918.

Robinia viscosa, Vent. The Michigan Flora gives but one station, Ionia. Dr. Nieuwland has found it on the clay cliffs north of Stephensville. The location is a wild place with no possibility that the species has been planted there. July 20, 1918.

Meibomia nudiflora (L.) O. K. f. *foliolata* Farwell. This form with leaves on the scapes, Dr. Nieuwland has found in the vicinity of Christiana Lake, North of Elkhart, Aug. 6, 1924.

All of the three lower racemes have from 2 to 3 leaves below the flower axils.

Galinsoga parviflora, Cav. var. *hispida*, DC. Dr. Nieuwland collected *Galinsoga* from near Christiana Lake, which proves to be this variety, the only form of the species known to occur in Michigan. The Michigan Flora gives *Galinsoga parviflora* Cav. at Detroit on the authority of W. S. Cooper; but all that occurs in Detroit and it is abundant there, is of

this variety. Recently, Blake has renamed it *G. ciliata* (Raf.) Aug. 10, 1924.

Echinops sphaerocephalus, Linn. This species is one of the thistle tribe, often cultivated in this country whence it escapes to waste places. Dr. Nieuwland has found a large stand of it on the road to Adamsville.

Selaginella rupestris (Linn.) Spring. Four mile Road, Detroit. This is a new station for this species in Michigan, perhaps the furthest south known.

Xyris flexuorsa, Muhl. At Bankson Lake, Cass Co., Aug. 24, 1914.

Quercus Primnus, Linn. Between Horbert and Sawyer on sand dunes in Berrien Co., July 22, 1918. Probably new to the State as I have seen no record of this species from Michigan.

Persecaria grandifolia, Sheld. In Bankson Lake, July 20, 1918. Stems assurgently rising over 1 foot out of the water.

Silene conica, Linn. Adventive at Stevensville, 1911. Probably the first record for this State. (See Midl. V. II., p. 264.)

Thlaspi arvense, Linn. Benton Harbor.

Drosera longifolia, Linn. (*D. intermedia Hayne*). Manistee, Aug. 30, 1919.

Althaea officinalis Linn. An escape along the tracks of the Michigan Central at Galien.

Malva sylvestris Linn. Associated with *Althaea*, just mentioned.

Hibiscus Moscheutos, Linn. This has the peduncles adnate to the peticles. River bottoms at St. Joseph. Aug. 10, 1918.

Viola candidula, Nieuwd. Benton Harbor.

Lepargyroea canadensis (L.) Greene. Sand dunes at Stevensville, July 20, 1918.

Sabbatia angularis (L.) Pursh. At Bankson Lake, Aug.

17, 1915. Found only in the southwestern part of the State.

Catalpa Kaempferi, Lieb. and Zucc. Persistant in a deserted yard east of Bankson Lake, Cass Co. Aug. 24, 1914.

DEPARTMENT OF BOTANY,
Parke, Davis & Co.,
Detroit, Mich.

The Native Flora of the Vicinity of Cold Spring Harbor, N. Y.

Continued from November Issue.

N. M. GRIER.

The following species of diatoms, normally part of the plankton of adjoining regions may under varying conditions be found in Cold Spring Harbor, according to Bigelow* and Fish.**

BIDDULPHIOIDEAE.

Bacteriastrum delicatulum (Cleve)—C. J. Fish.
Bacteriastrum sp.—H. B. Bigelow.
Bellerochea malleus (Brightw.)—C. J. Fish.
Biddulphia alterans (Bailey) v. h.—C. J. Fish.
Biddulphia favus (Ehrb.) v. h.—C. J. Fish.
Biddulphia granulata (Roper)—C. J. Fish.
Biddulphia biddulphiana (Smith)—C. J. Fish.
Biddulphia rhombus (Ehrb.)—C. J. Fish.
Biddulphia vesiculosa (Agard.)—C. J. Fish.
Chaetoceros atlanticum (Cleve)—C. J. Fish.
Chaetoceros boreale (Schütt.)—C. J. Fish.
Chaetoceros cinctum (Gran)—C. J. Fish.
Chaetocoros coarctatum (Lauder)—C. J. Fish.
Chaetoceros contortum (Schütt.)—C. J. Fish.
Chaetoceros eriophilum (Castr.)—C. J. Fish.
Chaetoceros danicum (Cleve)—C. J. Fish.
Chaetoceros debile (Cleve)—C. J. Fish.
Chaetoceros decipiens (Cleve)—C. J. Fish.
Chaetoceros densum (Cleve)—C. J. Fish.
Chaetoceros diadema (Ehrb.)—C. J. Fish.

---

* 1912. Bigelow, H. B. Exploration of the coastal water of the N. E. United States in 1916 by the U. S. Fisheries Schooner Grampus. Bull Mus. Com. Zoology at Harvard College. Vol. LXV., No. 5.

** Fish, C. J. From manuscript dealing with the plankton of the Woods Hole, Mass., region to be published by the U. S. Bureau of Fisheries.

Chaetoceros didymum (Ehrb.)—C. J. Fish.
Chaetoceros laciniosum (Schütt.)—C. J. Fish.
Chaetoceros lorenzianum (Gran)—C. J. Fish.
Chaetoceros mitra (Bailey)—C. J. Fish.
Chaetoceros peruvianum (Brightw.)—C. J. Fish.
Chaetocerios schuttii (Cleve)—C. J. Fish.
Chaetocerios schüttii (Cleve)—C. J. Fish.
Chaetoceros teres (Cleve)—C. J. Fish.
Chaetoceros willei (Gran)—C. J. Fish.
Chaetoceros sp.—H. B. Bigelow and C. J. Fish.
Climacodium biconcavum Cl.—H. B. Bigelow.
Ditylium brightwelli (West)—C. J. Fish.
Ditylium sp.—C. S. H. vicinity—N. M. G.

DISCOIDEAE.

Actinoptychus undulatus (Kuetz) Ralfs—C. J. Fish.
Coscinodiscus sp.—H. B. Bigelow.
Coscinosdiscus subbulliens (Ehrb.)—H. B. Bigelow.
Hyalodiscus stelliger (Bailey)—C. J. Fish.
Lysigonium moniliforme (Muell.)—Link.
Melosira sulcata (Kuetz)—C. J. Fish.
Skeletonema costatum (Grev.)—C. J. Fish.
Stephanopyxis Turris (Grev.) Ralfs—C. J. Fish.
Stephanopyxis sp.—H. B. Bigelow.
Thalassiosira decipiens (Grun)—C. J. Fish.
Thalassiosira hyalina (Grun)—C. J. Fish.
Thalassiosira nordenskioldii (Cleve)—C. J. Fish.

FRAGILLARIOIDEAE.

Asterionella japonica (Cleve)—H. B. Bigelow and C. J. Fish.
Fragilaria crotonensis (M. Edwards)—C. J. Fish.
Grammatophora marina (Lyngb.) Kuetz.—C. J. Fish.
Grammatophora serpentina (Ehrb.)—C. J. Fish.
Licmophora flavellata (Smith)—C. J. Fish.
Licmophora lyngbyei (Kütz) Grun.—C. J. Fish.
Rhabdonema adriaticum (Kütz)—C. J. Fish.
Striatella unipunctata (Lyngby) Ag.—C. J. Fish.
Synedra gallionii (Boyer)—C. J. Fish.
Synedra undulata (Bailey)—C. J. Fish.

Thalassiothrix frauenfeldii (Grun)—C. J. Fish, H. B. Bigelow.
Thalassiothrix longissima (Cleve and Grun)—C. J. Fish and H. B. Bigelow.
Thalassiothrix nitzschioides (Grun)—C. J. Fish and H. B. Bigelow.

NAVICULOIDEAE.

Nitzschia closterium (Smith)—C. J. Fish.
Nitzschia longissima (Breb.) Ralfs—C. J. Fish.
Nitzschia paxillifer (O. F. Mueller) Heiberg—C. J. Fish.
Nitzschia seriata (Cleve)—H. B. Bigelow and C. J. Fish.

SOLENIOIDEAE.

Corethron valdiviae (Karstan)—C. J. Fish.
Guinardia sp.—H. B. Bigelow.
Guinardia flaccida (Castr.)—C. J. Fish.
Leptocylindrus danicus (Cleve)—C. J. Fish.
Rhizoselenia alata (Brightw.)—H. B. Bigelow.
Rhizoselenia alata f. *genuina* (Gran)—C. J. Fish.
Rhizoselenia alata f. *gracillima* (Cleve)—C. J. Fish.
Rhizoselenia calcar avis (Schultze)—H. B. Bigelow.
Rhizoselenia delicatula (Cleve)—H. B. Bigelow.
Rhizoselenia faeroeensis (Ostf.)—H. B. Bigelow.
Rhizoselenia hebetata var. *semispina* (Henson)—H.B.Bigelow.
Rhizoselenia obtusa (Henson)—H. B. Bigelow.
Rhizoselenia setigera (Brightw.)—H. B. Bigelow.
Rhizoselenia shrubsolei (Cleve)—H. B. Bigelow.
Rhizoselenia styliformis (Brightw.)—H. B. Bigelow.

III.—FLAGELLATAE.*

EUGLENACEAE.

Euglena viridis Ehrb. C. S. H.—N. M. G.
Euglena spirogyra Ehrb. C. S. H.—N. M. G.
Peranema trichphorum Ehrb. 2nd lake. C. S. H.—L. N. J.
Phasus triqueter Ehrb. C. S. H.—A. A. Schaeffer.
Phacus longicauda Ehrb. C. S. H.—A. A. Schaeffer.
Trochelomonas hispida Stein. C. S. H.—A. A. Schaeffer.
Trochelomonas volvocina Ehrb. C. S. H.—A. A. Schaeffer.

OCHROMONADACEAE.

Dinobryan sp. 1st lake, C. S. H.—L. N. J.
Uroglena voluox Ehrb., 2nd Lake, C. S. H.—L. N. J.

IV.—DINOFLAGELLATAE.*

GYMNODINIACEAE.

**Gymnodinium gracile* (Bergh)—C. J. Fish.
Gymnodinium sp. C. S. H.—N. M. G.

PERIDINIACEAE.

Ceratium tripos Nitzsch. C. S. H.—D. S. J.
**Ceratium longipes* (Nitzsch) Bail.—H. B. Bigelow and C. J. Fish.
**Ceratium fusus* (Nitzsch) Duj.—H. B. Bigelow and C. J. Fish.
**Ceratium macroceras* (Nitzsch) Ehrb.—H. B. Bigelow and C. J. Fish.
**Ceratium bucephalum* (Nitzsch) Cl.—H. B. Bigelow and C. J. Fish.
**Ceratium heterocamptum* (Nitzsch)—H. B. Bigelow and C. J. Fish.
Dinophysis caudata Kent, C. S. H.—N. M. G.
**Glenodinium compressa* Calkins—C. J. Fish.
**Gonyaulax tricantha* Jorg.—C. J. Fish.
**Peridinium depressum* Bailey—C. J. Fish.
**Perilinium oceanicum* var. *oblongum* Aurivillus—C. J. Fish.
Peridinium sp.

SILICOFLAGELLATAE.

Distephanus speculum Haeckel—C. J. Fish.
Dictyocha fibula Ehrb.—C. J. Fish.

---

* Species starred are those normally a part of the plankton of the adjoining regions, and under varying conditions may be found in Cold Spring Harbor. I am indebted to Dr. C. J. Fish of the U. S. Bureau of Fisheries, Woods Hole, Mass., and Dr. H. B. Bigelow, Museum of Comparative Zoology, Harvard College, Cambridge, Mass., for the data they have supplied.

* Nomenclature revised provisionally by Professor C. A. Kofoid, University of California for whose cooperation the writer desires to express his appreciation.

VI.—CONJUGATAE.*

DESMIDIACEAE.

Arthrodesmus convergens Ehrb. Common in Jarvis Pond, C. S. H.—L. N. J.

Arthrodesmus fragilis Wolle. Common in Jarvis Pond, C. S. H.—L. N. T.

Cosmarium Everettense Wolle. Common in Jarvis Pond, C. S. H.—L. N. J.

Cosmarium ornatum Ralfs. Common in Jarvis Pond, C. S. H. —N. M. G.

Cormarium ovale Ralfs. Common in Jarvis Pond, C. S. H.—L. N. J.

Cosmarium tetropthalmum (Kg.) Breb. Common in Jarvis Pond, C. S. H.—L. N. J.

Desmidium baileyii (Ag.) Ralfs. Common in Jarvis Pond, C. S. H.—L. N. J.

Eurastrum verucosum (Ehrb.) Ralfs. Common in Jarvis Pond, C. S. H.—L. N. J.

Hyalotheca dissiliens var. *apiculata* Ehrb. (Breb.) Common in Jarvis Pond, C. S. H.—L. N. J.

Micrasterias fimbriata (Ralfs.) Nordst. Common in Jarvis Pond, C. S. H.—L. N. J.

Micrasterias laticeps Nord. Jarvis Pond, C. S. H.—N. M. G.

Micrasterias muricata Bailey. Jarvis Pond, C. S. H.—L.N.J.

Micrasterias radiata Hass. Common in Jarvis Pond, C. S. H. —L. N. J.

Micrasterias Sol (Ehr.) Kuetz. Common in Jarvis Pond, C. S. H.—L. N. J.

Netrium digitus (Ehr). Itzigs and Rothe. Common in Jarvis Pond, C. S. H.—N. M. G.

Penium libellula (Focke) Nordst. C. S. H.—L. N. J.

Spondylosium tetragonum West. Jarvis Pond, C.S.H.—L.N.J.

Staurastrum Artiscon, (Ehr.) Lund. Jarvis Pond, C. S. H. L. N. J.

Staurastrum crenulatum (Naeg.) Delp. Jarvis Pond, C. S. H. —N. M. G.

Staurastrum cuspidatum Breb. Jarvis Pond, C. S. H.—L.N.J.

Staurastrum gracile Ralfs. Jarvis Pond, C. S. H.—L. N. J.

Staurastrum pentacladium Wolle. Jarvis Pond, C. S. H.—L. N. J.

Staurastrum tohopekaligense Wolle. Jarvis Pond, C. S. H.—L. N. J.

Staurastrum vestitum Ralfs. Jarvis Pond, C. S. H.—L. N. J.

MESOTAENIACEAE.

Closterium didymoticum Corda. Jarvis Pond, C. S. H.—N. M. G.

Closterium moniliferum (Broy.) Ehrb. Jarvis Pond, C. S. H.—L. N. J.

Gymnozyga moniliformis Ehr. Jarvis Pond, C. S. H.—L.N.J.

Spirotaenia condensata Breb. Jarvis Pond, C. S. H.—L. N. J.

ZYGNEMATACEAE.*

Spirogyra orthospira (Naeg.) Jarvis Pond, C. S. H.—L.N.J.

Spirogyra mirabile, (Hass) Kuetz. Jarvis Pond, C. S. H.—L. N. J.

Spirogyra varians (Hass) Kuetz. Fish Hatchery Pond, C. S. H.—E. N. T.

---

* Revised following principally the nomenclature given in "British Desmidiaceae" Vol. I-IV. W. West and G. S. West, Vol. V. Nellie Carter. London, 1905, 1908, 1909, 1912 and 1923. Published by the Ray Society.

Revised following Collins, *loc cit.*

Zygnema cruciatum (Vauch.) Agardh. Glen Cove, L. I.—Jelliffe.

Zygnema pectinatum (Vauch.) Agardh. 1st Lake, C. S. H.—L. N. J.

Zygnema stellinum, Ag. (Muell.) Agardh. Jarvis Pond, C. S. H.—L. N. J.

Other CONJUGATAE listed by Jelliffe as being frequent throughout the island in pond, etc., are (Desmidiaceae.)

Arthrodesmus Incus (Breb.) Hass.

Cosmarium botrytis Menegh.

Cosmarium Dianae Ehrb.

Cosmarium moniliforme (Turp.) Ralfs.

Cosmarium subcostatum (Nordst.) var. *Beckii* Gutw.

Euastrum ansatum Ralfs.

Micrasterias Americana (Ehrb.) Ralfs.
Micrasterias Torreyi Bailey.
Staurastrum aristiferum Ralfs.
Staurastrum brachiatum Ralfs.
Staurastrum brevispium Breb.
Staurastrum dejectum Breb.
Staurastrum hirsutum (Ehrb.) Breb.
Staurastrum polymorphum Breb.
Staurastrum punctulatum Breb.
Staurastrum Sebaldi Reinsch.
Xanthidium cristatum Breb.

MESOTAENIACEAE.

Closterium Dianae Ehrb.
Closterium Ehrenbergii Menegh.
Closterium gracile Ehrb.
Closterium striolatum Ehrb.
Closterium rostratum Ehrb.
Docidium crenulatum (Ehrb.) Rab.
Pleurotaenium Ehrenbergii (Ehrb.) Naeg.
Closterium Lunula (Muell.) Ehrb.

VII.—CHLOROPHYCEAE.*

BOTRYDIACEAE.

Botrydium granulatum (L.) Grev. Meadows south of lakes, C. S. H.—N. M. G.

BRYOPSIDACEAE.

Bryopsis plumosa (Huds.) Agardh. Occasional on rocks and wharves at month of harbor, C. S. H.—D. S. J.
Chaetomorpha aerea (Dillw.) Kuetz. Bottom of harbor, C. S. H.—D. S. J.
Chaetomorpha aered forma *linum* (Fl. Dan.) Collins. Inner Harbor near sandspit, C. S. H.—N. M. G.
Rhizoclonium riparium (Roth) Harvey. Stones, mats, on *Spartina*, in brookish water, C. S. H.—H. H. Y.
Rhizoclonium tortuosum Kuetz. Mats and tangles on mud. brookish water, C. S. H.—D. S. J. and H. H. Y.
Rhizoclonium sp. Two speeics, old pier, mud, C. S. H. — D. S. J.

CHAETOPHORACEAE.

Chaetophora sp. In fish boxes near church at 1t. lake, C. S. H.—H. H. Y.

Chastophora pisifornis (Roth) Ag. On *Fontinalis* at mill race from near lower pond, C. S. H.—D. S. J.

Draparnaldia plumosa (Vauch) Ag. Fish Hatchery pond—E. N. T.

Draparnaldia glomerata (Vauch) Ag. In pools, quite commonly distributed—Jelliffe.

CLADOPHORACEAE.

Cladophora expansa (Mert) Kuetz. Inner Harbor near the tide run.—N. M. G.

Cladophora fracta (Dillw.) Kuetz. Shoals at inner end of Center Island.—G. C. F.

Cladophora gracilis (Griff.) Kuetz. Laurelton pier.—H. H. Y.

Spongomorpha arcta (Dillw.) Kuetz. Common throughout L. I.—Jelliffe.

Spongomorpha lanosa (Roth) Kuetz. Not infrequent in Long Sound.—Jelliffe.

COELASTRACEAE.

Scenedesmus obliquus (Turp.) Kuetz. 2nd Lake, C. S. H.—N. M. G.

Scenedesmus obliquus (Turp) var. *dimorphus*. Hans. Frequent on L. I.—Jelliffe.

Scenedesmus quadricauda (Turp.) Bres. 2nd Lake, C. S. H.—N. M. G.

HYDRODICTYACEAE.

Pediastrum Boryanum (Turpin) Fish Hatchery pond, C. S. H.—E. N. T.

Pediastrum tetras (Ehr.) Ralfs. 2nd Lake, C.S.H.—N.M.G.

---

* Revised following nomenclature given in "The Green Algae of North America" F. S. Collins, Tufts College Studies, Scientific Series. Vol. 2, 3, 4. Additional publications used in making identifications in this and folloiwng two groups: were "Marine Algae of New England" W. C. Farlow. Report U. S. Commissioner of Fish and Fish-Adjacent Regions" W. D. Hoyt. Bulletin U. S. Bureau of Fisheries, Vol. 36, 1917-18.

Pediastrum duplex (Meyen) Kg. 2nd Lake, C.S.H.—N.M.G.
Hydrodictyon Reticulatum (L.) Lager. Frequent throughout L. I.—Jelliffe.

OEDOGONIACEAE.

Oedogonium crassiusculum, var. *Idios* Wittr. Dying pond, C. S. H.—E. N. T.
Oedogonium grande, Kg. Fish Hatchery pond, C. S. H.—E. N. T.
Oedogonium Pringsheimii Cram. On *Ceratophyllum* in 1st Lake, C. S. H.—D. S. J.
Oedogonium rufescens var. *exiguum* Wittr. Dying pond, C. S. H.—E. N. T.

PLEUROCOCCACEAE.

Pleurococcus vulgaris Menegh., C. S. H. vicinity—N. M. G.
Stichococcus bacillaris. Naeg., C. S. H. vicinity—D. S. J.

PROTOCOCCAEAE.

Palmellococcus miniatus (Leib) Chodat, C.S.H.—N.M.G.
Zoochlorella parasitica (Beyer) Brandt. On fresh water sponge in dying pond, C. S. H.—E. N. T.

TETRASPORACEAE.

Dictyosphaerium Ehrenbergianum Naeg. Frequent.—Jelliffe
Kirchnerella lunaris (Kirchner) Moebius. Frequent, L. I.—Jelliffe.
Rhaphidium falcatum (Cooke) var. *aciculare* (A. Br.) Hans. C. S. H.—E. N. T.
Tetraedron regulare var. *longispinum* (Perty) Hans. Frequent. L. I.—Jelliffe.
Tetraspora lubrica (Roth) Ag. Frequent throughout.—Jelliffe.

ULVACEAE.

Enteromorpha plumosa Kuetz. Near Laurelton pier.—H.H.Y.
Enteromorpha prolifera (Fl. Dan.) J. Ag. Estuary, C. S. H.—D. S. J.
Ilea fulvescens (Ag.) J. G. Ag. Estuary, C. S. H.—N. M. G.
Monostroma crepidinum Farl. Estuary, C. S. H.—D. S. J.
Monostroma latissimum (Kuetz) Wittr. Fresh water inlets, C. S. H.—H. H. Y. and D.S.J.

Monostroma pulchrum Farlow. Frequent.—Jelliffe.
Ulva Lactuca. (L) Le Jolis var. *latissima Le Jolis.* On muddy bottom, C. S. H.—D. S. J.

VALONIACEAE.

Dictyocystis Hitchcockii (Wolle) Lag. Common bottom 2nd Lake, C. S. H.—N. M. G.

VAUCHERIACEAE.

Vaucheria sessilis (Vauch) De Cond. In springs and pools back of school house, C. S. H.—D. S. J.
Vaucheria Thuretii Wor. Near fresh water inlets, wet areas near tide pools, C. S. H.—D. S. J.

VOLVOCACEAE.

Chlamydomonas sp. Common—Jelliffe.
Gonium pectorale Muell. Frequent throughout the island.—Jelliffe.
Haematococcus pluvialis (Flotow) Sommerf. Common throughout.—Jelliffe.
Pandorina Morum (Muell.) Bory. C. S. H.—D. S. J.
Volvox aureus Ehr. Ponds,C. S. H.—E. N. T.
Volvox globator L. Not infrequent. Local.—Jelliffe.

CHAROPHYTA.

CHARACEAE.

Chara formosa C. B. Robinson. Southold, L. I.—Burnham and Latham.*
Nitella flexilis Ag. Southold, L. I.— Burnham and Latham.
Nitella intermedia L. Southold, L. I.—Burnham and Latham.
Nitella transilis Allen. Southold, L. I.—Burnham & Latham.
Nitella sp. Dying Pond. Cold Spring Harbor.—O. E. J.

PHAEOPHYCEAE.*

CHORDARIACEAE.

Chorda Filum (L) Stack. Frequent on stones at Lloyd's Point, L. I.—D. S. J.
Leathesia difformis (L) Aresch. Occasional on *Fucus* at Loyd's Point, L. I.—D. S. J.

---

* *Torreya* 23.

DESMERESTIACEAE.

Desmerestia viridis (Fl. Dan.) Lamx. Common throughout sound.—Jelliffe.

DICTYOSIPHONACEAE.

Dictyosiphon foeniculasius (Huds.) Grev. Not infrequent along coast.—Jelliffe.

ECTOCARPACEAE.

Ectocarpus confervoides (Roth) Le Jolis. C. S. H.—D.S.J.

Ectocarpus fasciculatus, Harvey. Not infrequent on L. I. —Jelliffe.

Ectocarpus siliculosis (Dillw.) Ag. Sticks, stones, inner harbor, C. S. H.—D. S. J.

Ectocarpus tomentosus Lyngb., C. S. H.—D. S. J.

Elachistea fucicola (Valley) Fries. Long Island Sound.—N. M. G.

Mesogloia divaricata (Ag.) Kuetz. Common flats inner harbor, C. S. H.—D. S. J.

Myrionema vulgare. Thur. L. I. Sound, stone pier, C. S. H. —N. M. G.

Myriotricha filiformis. Harv. Tide stream Center Island growing on *Zostera.*—G. C. F.

Pylaiella littoralis (L) Kjell. Inner harbor, inlet on sticks and stones.—D. S. J. and H. H. Y.

---

* Manuscript of this group and of the Rhodophyceae revised by Professor I. F. Lewis of the Marine Biological Laboratory, Woods Hole, Mass., and The University of Virginia.

Scytosiphon lomentarius (Lyngb.) J. Ag. Inner harbor, C. S. H.—D. S. J. and H. H. Y.

Stilophora rhizoides (Ehrb.) J. Ag. Long Island Sound.—Jelliffe.

Streblonema reptans (Crouan) Farlow, C. S. H.—D. S. J.

ENCOELIACEAE.

Punctaria latifolia Grev. Common throughout L. I.—Jelliffe.

Punctaria plantaginea (Roth) Grev. Not infrequent on L. I. —Jelliffe.

Petalonia fascia (Mueller) Kuetz. Common throughout coast —Jelliffe.

FUCACEAE.

Ascophyllum nodosum (L) Le Jolis. Common on rocks, outer and inner harbor, C. S. H.—D. S. J.

Fucus evanescens Ag. Common on rocks, C. S. H.—D. S. J.

Fucus platycarpus Thuret. Stones, piles, docks, inner harbor.—D. S. J.

Fucus vesiculosus (L). Common on rocks inner and outer harbor.—D. S. J.

Fucus vesiculosus (L) var. *spiralis* Farlow, C .S. H., Lloyd's Pt., L. I.—D. S. J.

Sargassum bacciferum (Turn.) J. Ag. Washed ashore throughout L. I.—Jelliffe.

Sargassum filipendula Ag. Frequent on rocks at Lloyd's Pt., L. I.—D. S. J.

LAMINARIACEAE.

Laminaria Agardhii Kjell. Found all along coast, L. I.—Jelliffe.

RALFSIACEAE.

Ralfsia Bornetii Kuckuck. Reported from Connecticut.—I. F. Lewis.

Ralfsia clavata (Carm.) Farlow. Piles, docks, inner harbor, C. S. H.—D. S. J. and H. H. Y.

Ralfsia verrucosa Aresch. Reported from Connecticut.—I. F. Lewis.

SPHACELARIACEAE.

Sphacelaria cirrhosa (Roth) Ag. Common on *Fucus* in Sound.—D. S. J.

Sphacelaria radicans (Dillw.) Ag. Dredged near lighthouse, C. S. H.—D. S. J.

STRIARACEAE.

Striaria attenuata Grev. Not infrequent on L. I. Sound.—Jelliffe.

RHODOPHYCEAE.

BANGIACEAE.

Bangia ceramicola Chauv. Occasional on *Ceramium*. C. S. H. —D. S. J.

Bangia fusco-purpurea (Dillw.) Lyngb. Common throughout on piling.—Jelliffe.

Porphyra Laciniata (Lightf.) Ag. Common on stones, tidal inlets, C. S. H.—D. S. J.

CERAMIACEAE.

Antithamnion americanum (Herv.) Farlow. Lloyd's Point, L. I.—N. M. G.

Antithanion cruciatum (Ag.) Naeg. On rocks Lloyd's Point, L. I.—N. M. G.

Callithamnion Borreri (Eng. Bot.) Harv. Common throughout.—Jelliffe..

Professor Lewis states this species is not recognized as occurring on the New England Coast, and that the species meant it is possibly *C. corymbosum* (Eng. Bot.) Ag.

Callithamnion Baileyi, Harv. Common throughout.—Jelliffe.

Callithamnion byssoideum Arn. Not infrequent throughout. —Jelliffe.

Callithamnion roseum (Roth) Harvey, Lloyd's Pt. L. I. Tidal inlets, C. S. H.—D. S. J.

Ceramium circinnatum Kuetz. Glen Cove, L. I.—Jelliffe.

Ceramium fastigiatum Harv. Not infrequent in L. I. Sound. —Jelliffe.

Ceramium rubrum (Huds.) Ag. On rocks Eaton's Point, abundant on *Zostera* off sandspit.—N. M. G.

Ceramium rubrum var. *proliferum*, Harvey, Eaton's Point, L. I.—N. M. G.

Ceramium strictum (Kuetz) Harv. Common on *Zostera*, C. S. H.—D. S. J.

Ceramium tenuissimum (Lyngb.) J. Ag. Common throughout sound.—Jelliffe.

Griffithsia globifera (Harv.) J. Ag. Occasional on rocks at Lloyd's Pt., L. I.—D. S. J.

Plumaria elegans (Bonnam) Schmitz, Common throughout. —Jelliffe.

Seirospora Griffithsiana, Harv. Not infrequent throughout. —Jelliffe.

Spermothamnion Turneri (Mert.) Aresch. Not infrequent in Sound and harbors south shore.—Jelliffe.

Spyridia flamentosa (Wolf.) Harv. Near Laurelton, L. I.—N. M. G.

CORALLINACEAE.

Melobesia farinosa Lam. Glen Cove, Greenport, L. I.—Jelliffe.

DELESSERIACEAE.

Caloglossa Le prieurii (Mont.) J. G. Ag. Inner harbor, Tidal Inlet, C. S. H.—D. S. J.

Grinnellia americana (Ag.) Harv. Common inner harbor, C. S. H.—D. S. J.

GELIDIACEAE.

Gelidium crinale (Turn) J. Ag. On rocks, Lloyd's Point, L. I.—D. S. J.

Hildenbrandtia Prototypus Nardo. Inner harbor, Tidal Inlet, C. S. H.—D. S. J.

Hildenbrandtia rosea Kuetz. Common on stones, pebbles, C. S. H.—D. S. J.

GIGARTINACEAE.

Ahnfeltia plicata (Turn) Fries. On rocks, shells, Lloyd's Pt., L. I.—D. S. J.

Chondrus crispus (L) Stack. Common on rocks at Lloyd's Pt., L. I.—D. S. J.

Phyllophora membranifolia (Good and Wood) J. Ag., C. S. H. vicinity.—N. M. G.

HELMINTHOCLADIACEAE.

Batrachosperum moniliforme (Roth). Frequent fresh water. —Jelliffe.

Chantransia virgatula (Harv.) Thur. Dredged near light-house, C. S. H.—D. S. J.

Nemalion multifidum (Web and Mohr) J. Ag. Frequent Lloyd's Pt.—D. S. J.

RHODOMELACEAE.

Bostrychia rivularis Harv. On wood, stones, C. S. H.—H. H. Y.

Chondria atropurpurea Harv. Glen Cove, L. I.—Jelliffe.

Chondria dasyphylla (Woodw.) Ag. On rocks Lloyd's Pt.—D. S. J.

Chondria tenuissima (Good and Koodw.) Ag. var. *baileyana* (Harv.)—D. S. J. and J. Ag. On rocks Lloyd's Pt., inner harbor tidal inlet.—H. H. Y.

Dasya elegans (Mart) Ag. On rocks, inner harbor, tidal inlet, C. S. H.—D. S. J.

Polysiphonia fastigiata (Roth) Grau? Glen Cove, L. I.—Jelliffe.

Polysiphonia Harveyi, Bailey. Not infrequent, L. I. Sound. —Jelliqe.

Polysiphonia nigrescens (Dillw.) Grev. Common along coasts. —Jelliffe.

Polysiphonia Olneyi, Harv. Eaton's Neck, L. I.—H. H. Y. and D. S. J.

Polysiphonia urceolata (Lightf.) Grev. Common on coasts. Jelliffe.

Polysiphonia variegata (Ag.) Zan. Eaton's Point, Sandspit, C. S. H.—D. S. J.

Rhodomela subfusca (Woodw.) Ag. Not infrequent on coasts.—Jelliffe.

RHODOPHYLLIDACEAE.

Agardhiella tenera (J. Ag.) Schmitz, C. S. H. vicinity.—D. S. J.

Cystoclonium purpurascens (Huds.) Kuetz Common throughout.—Jelliffe.

Euthora cristata (L) J. Ag. Infrequent throughout coast. —Jelliffe.

RHODYMENIACEAE.

Champia parvula (Ag.) Harv. Occasional on rocks, Lloyd's Pt., L. I.—D. S. J.

Halosaccion ramentaceum (L) J. Ag. Not infrequent along coast.—Jelliffe.

Lomentaria uncinata Menegh. Sandspit, C. S. H.—N. M. G.

Rhodymenia palmata (L) Grev. Not infrequent along coast.

SPHAEROCOCCACEAE.

Gracilaria multipartita (Clem) Ag. Common along coasts. —Jelliffe.

SQUAMARIACEAE.

Petrocelis cruenta J. Ag. Inner harbor, Tidal Inlet—D. S. J, and H. H. Y.

Peyssonellia Rosenvingii Schmitz, C. S. H. Vicinity on pebbles, shells.—D. S. J.

EUMYCETES.*

PHYCOMYCETES.

ALBUGINACEAE.

Albugo portulacae (DC) O. Kuetz. On *P. olevacea* in gardens, C. S. H.—A. F. B.

Cystopus candidus (P.) Lev. On *Sisymbrium officinale* by roadsides, C. S. H.—M. A. B.

ANCYLISTACEAE.

Ancylistes closterii Pfitzer. Parasitic in *Closterium*, C. S. H.—N. M. G.

MUCORACEAE.

Calyptromyces ramosus Karst. Not infrequent on Long Isl. and.—Jelliffe.

Mucor Mucedo (L.) Ehr. Frequent.—Jelliffe.

Phycomyces nitens (Agard) Kuetz. Growing on dung in woods, C. S. H.—A. F. B.

Syzygites aspergillus (Scop.) Pound. Center Island.—N. M. G.

PERONOSPORORACEAE.

Peronospora parasitica (Pers) Fries. On *Lepidium virginicum*, C. S. H.—A. F. B.

SYNCHYTRIACEAE.

Synchytrium decipiens Farlow. Common on *Amphicarpa monoica*, C. S. H.—A. F. B.

---

*I am indebted to Dr. A. H. Graves, Brooklyn Botanic Garden, for revision of this list with regard to its most convenient use, according to Saccardo's "Sylloge Fungorum," Oudeman's "Enumeratio Systematic Fungorum, and Engler and Prant.

ASCOMYCETES.

ASCOBOLACEAE.

Ascophonus carneus (Pers) Boud. On dung at Lloyds Neck. —N. M. G.

Ascobolus stercovarius (Bull.) Schr. On cowdung at 1st lake. —A. F. B.

ASPERGILLACEAE.

Asperpillus glaucus (L) LK. Common throughout island.—Jelliffe.

Penicillium crustaceum Fr. Frequent throughout Long Island—Jelliffe.

CENANGIACEAE.

Bulgaria inquinans (Pers) Fr. On logs west of lakes.—C. S. H.—D. S. J.

CHAETOMIACEAE.

Eutypella glandulosa (CK.) Ell. Not infrequent on *Ailanthus*.—Jelliffe.

Diatrype stigma (Hoff) Fr. Frequent throughout.—Jelliffe.

Nummularia Bulliardi Tul. Frequent throughout.—Jelliffe.

Ustilina vulgaris Tul. Frequent throughout.—Jelliffe.

DOTHIDIACEAE.

Microsphaera alni (Wallr.) Salmon. On lilac back of De Forest estate.—M. A. B.

Microsphaera grossulariae (Wallr.) Lev. On leaves of *Sambucus Canadensis*.—Jelliffe.

ERYSIBACEAE.

Microsphaera quercina (Schw.) Burrill. On *Quercus alba*, Jamaica.—Jelliffe.

Phyllactinia guttata Lev. On chestnut leaves. Jamaica, L. I. —Jelliffe.

Sphaerotheca Castagni Lev. Frequent throughout.—Jelliffe.

EXOASCACEAE.

Taphrina alnitorqua (Tul.) Kuhn. Common on *Alnus incana*. —A. F. B.

GEOGLOSSACEAE.

Geoglossum americanum (Cooke) Sac. On moss, C. S. H.—D. S. J.

Geoglossum glutinosum. Pers. On moss near 3rd lake, C. S. H.—M. A. B.

Geoglossum ophioglossoides (L.) Saccardo. Mossy Banks. C. S. H.—D. S. J.

Leotia chlorocephala Schw. Marshy ground.—M. A. B.

Leotia lubrica (Scop.) Pers. Common on ground, C. S. H.—N. M. G.

Leotia viscosa (Fr.) Schr. Occasional in woods, C. S. H.—D. S. J.

HELOTIACEAE.

Chlorosplenium aeruginosom (Oed.) DeNot. Decayed wood, C. S. H.—A. F. B.

Helotium citrinum (Hedw.) Fr. Frequent, L. I.—Jelliffe.

Helotium subsessile. Schum. Rotten twigs, C. S. H.—N.M.G.

Monilia cinerea (?) Bon. On plum trees, C. S. H.—A. F. B.

Sarcosscypha coccinea (Scop.) Sacc. C. S. H.—M. A. B.

Sclerotina fructigena (Pers.) Schroet. On peach trees, C. S. H.—A. F. B.

HELVELLACEAE.

Helvella crispa (Scop) Fr. Marsh near 2nd lake, C. S. H.—A. F. B.

Helvella lacunosa Fries. On ground in woods, C. S. H.—D. S. J.

Morchella esculenta (L) Pers. Infrequent, L. I.—Jelliffe.

HYPOCREACEAE.

Chromacrea gelatinosa (Tode) Fr. On rotten logs near first lake, C. S. H.—A. F. B.

Hypocrea rufa (Pers) Fr. Frequent, L. I.—Jelliffe.

Hypomyces chrysospermum (Bull) Tul. Common in woods, C. S. H.

Hypomyces hyalinus. (Schw.) Tul. Common in woods, C. S. H.—A. F. B.

Hypomyces Lactifluorum (Schw.) Tul. Glen Cove, L. I.—Jelliffe.

Nectria Peziza (Tode) Fr. West of lakes on dead limbs, C. S. H.—A. F. B.

MELOGRAMMATACEAE.

Endothia parasitica (Murrill) Anderson. Chestnut trees, C. S. H.—M. A. B.

PEZIZACEAE.

Lachnea scutellata (L.) Sacc. Common on logs, C. S. H.—M. A. B.

Peziza pustullata. Pers. On ground near 1st lake, C. S. H. —M. A. B.

PYRENONEMATACEAE.

Pyronema confluens Tul. 1st lake. C. S. H.—A. F. B.

RHIZINIACEAE.

Psilopeziza babingtonii Berk? Rotten logs near 1st lake, C. S. H.—D. S. J.

SACCHAROMYCETACEAE.

Saccharomyces agglutinus Fr. Common L. I.—Jelliffe.

Saccharomyces cerevisiae Meyen. Frequent L. I.—Jelliffe.

Saccharomyces niger Marp. Frequent L. I.—Jelliffe.

SPHAERIACEAE.

Rosellinia subiculata (Schw.) Sacc. On rotten wood, C. S. H. —M. A. B.

XYLARIACEAE.

Daldinia concentrica (Bolt.) Ces. and De Not. Frequent L. I. —Jelliffe.

Daldinia constricta De Not. On birch log in region of lakes, C. S. H.—M. A. B.

Hypoxylon coccineum Bull. On beech near lakes, C. S. H.— D. S. J.

Hypoxylon fuscum (Pers.) Fr. Frequent throughout L. I.— Jelliffe.

Hypoxylon multiforme Fr. C. S. H.—D. S. J.

Hypoxylon Sassafras (Schw.) Berk. Common throughout L. I.—Jelliffe.

Xylaria polymorpha Grev. On decaying logs near lakes. On sand, C. S. H.—M. A. B.

BASIDIOMYCETES.

AGARICACEAE.

Agaricus diminutivis Pk. In woods near DeForest Estate, C. S. H.—M. A. B.

Amanita Frostiana Pk. On ground at Center Island, C. S. H.—M. A. B.

Amanita muscaria (L.) Meadows, C. S. H.—M. A. B.

Amanita phalloides (Fr.) Quel. Glen Cove. L. I.—Jelliffe.

Amanita phalloides var. *viridis* Pers. Huntington Road, C. S. H.—M. A. B.

Amanita rubescens Fr., C. S. H.—M. A. B.

Amanita strobiliformus Fr., C. S. H.—M. A. B

Amanitopsis vaginata (Bull) Roz. Moist woods. 1st lake, C. S. H.—M. A. B. The three varieties listed as *alba.*, *fulva*, and *livida* are also reported.

Amanitopsis volvata Pk. On ground between 1st and 2nd lakes, C. S. H.—G. C. F.

Armillaria mellea Vahl. Frequent throughout island.—Jelliffe.

Boletinus cavipes (Opat). Kalckb. On ground near 2nd lake, C. S. H.—D. S. J.

Boletinus porosus var. *opacus* Pk. On ground west of lower lake, C. S. H.—D. S. J.

Boletinus porosus (Berk.) Pk. On moss, on ground old rail way survey west side of 2nd lake, C. S. H.—D. S. J.

Cantherellus cibarius Fr. On ground back of DeForest Estate, 1st and 2nd lakes, C. S. H.—D. S. J. and G. C. F.

Cantharellus cinnabarinus. Schw. On moss, C .S. H.—M.A.B.

Clitocybe candida Bres. On ground. C. S. H.—M. A. B.

Clitocybe gigantea (Quel.) Champ. Sandy soil., C. S. H.—M. A. B.

Clitocybe infundibuliformis. Bull. Ground in woods, C. S. H. —M. A. B.

Clitocybe media. Pk. Vicinity of lakes, C. S. H.—M. A. B.

Collybia butyracea (Bull.) Quel. On decayed leaves between 1st and 2nd lakes, C. S. H.—G. C. F.

Coprinus atramentarius. (Bull.) Fr. On barrens. Road to Hicksville, C. S. H.—M. A. B.

Coprinus micaceus (Bull) Fr. Glen Cove, L. I.—Jelliffe.

Cortinarius (Fr.) Sp. On dead and decaying leaves west of 1st and 2nd lakes, C S. H.—G. C. F.

Flammula carbonaria. Fr. Vicinity of lakes. On Moss, C. S. H.—M. A. B.

Flammula flavida (Pers.) Quel. Woods in vicinity of lakes on decayed logs, C. S. H.—M. A. B.

Hygrophorus cantharellus Schw. Fresh water marsh near fish hatchery, C. S. H.—M. A. B.

Hygrophorus conicus (Scop.) Fr. On ground in woods, C. S. H.—M. A. B.

Hygrophorus fuligineus. Frost., C. S. H.—M. A. B.

Hyphaloma Sublateritium (Schaeff.) Quel. Frequent throughout island.—Jelliffe.

Hyponeuris alneus (L.) Earl. On black Cherry bark, C. S. H.—M. A. B.

Inocybe cincinnata. (Fr.) Gillet. On ground beneath pine trees, C. S. H.—M. A. B.

Lactaria lignyotus. Fr. Near research laboratory in sandy soil, C. S. H.—M. A. B.

Lactaria piperatus. (L) Fr. Roads and woods,C. S. H.—M. A. B.

Lactaria vellerea. Fr. On ground in woods, C. S. H.—M. A. B.

Lactaria volemus. Fr. Sandy soil,C. S. H.—N. M. G.

Lepiota naucina. Fr. On ground between 1st and 2nd lakes, C. S. H.—G. C. F.

Leptoglossum sp. Swamp at 3rd lake, C. S. H.—N. M. G.

Marasmius foetidus. Sow. On twigs and old tree stumps near lakes, C. S. H.—M. A. B.

Marasmius nigripes. Schw. On oak leaves at DeForest Estate, C. S. H.—M. A. B.

Marasmius oreades (L) Fr. Frequent throughout island—Jelliffe.

Marasmius sarmentosus Berk. On fallen oak leaves and twigs. Huntington Rd., C. S. H.—A. F. B.

Nyctalus lycoperdoides (Bull) Schroet. On *Russula* sp. near Laurelton, C. S. H.—M. A. B.

Omphalia caespitosa Bot. Old tree stumps near DeForest Estate, C. S. H.—M. A .B.

Omphalia campanella Batsch. Mosses, old stumps, woods at left of lakes, C. S. H.—M. A. B.

Panaeolus campanulatus Linn. On horse dung west of 2nd lake, C. S. H.—G. C. F.

Panaeolus retirugis Fr. On horse dung west of 2nd lake, C. S. H.—G. C. F.

Panus albido-tomentosus. Cke. On twigs, C. S. H.—M. A. B.

Panus stypticus. Fr. Old logs Jones' wood, C. S. H.—M.A.B.

Panus torulosus. Fr. De Forest Estate, C. S. H.—M. A. B.

Pilosace exima. Pk. Decayed logs. De Forest Estate, C. S. H.—M. A. B.

Psalliota campestris L. Frequent throughout island—Jelliffe.

Pleurotus ostreatus (Jacq.) Fr. Frequent throughout island. —Jelliffe.

Pleurotus sapidus Kalckb. Trees near Fish Hatchery, C. S. H.—A. F. B.

Pleurotus ulmarius (Bull.) Quel. Glen Cove, L. I.—Jelliffe.

Russula alutacea Fr. Glen Cove, L. I.—Jelliffe.

Russula crustosa. Pk. Roadside De Forest Estate, C. S. H. M. A. B.

Russula cyanoxantha. Schaeff. Ground, woods near lake, C. S. H.—M. A. B.

Russula emetica Vitt., C. S. H.—M. A. B.

Russula purpurina Q. & S. On ground on road to Eugenics Record Office, C. S. H.—M. L. B.

Russula roseipes (Secr.) Bres. Back of DeForest Estate, C. S. H.—M. A.B.

Russula viresvens (Schaeff.) Fr., C. S. H.—M. A. B.

AURICULARIACEAE.

Calocera cornea (Batch) Fr., C. S. H.—A. F. B.

Dacrymyces chrysocomus. (Bull.) Tul. Rotten branches on ground, C. S. H.—G. C. F.

CALOSTOMATACEAE.

Calostoma cinnabarium Corda. Woods west of lakes, C. S. H. —A. F. B.

CLAVARIACEAE.

Clavaria amethystina, Bull. C. S. H.—M. A. B.

Clavaria circinans Pk. Woods near lakes. C. S. H.—M. A. B.

Clavaria coronata Schw. On birch, woods near 2nd lake, C. S. H.

Clavaria fusiformis Sow. Between 2nd and 3d lakes, C. S. H.—G. C. F.

Clyavaria pistillaris. L. Ground, between 1st and 2nd lakes. C. S. H.—G. C. F.

Clavaria stricta Pers. On ground, C. S. H.—M. A. B.

Lachnocladium Michinori. B. and C. On wet ground. Center Island,C. S. H.—M. A. B.

Sparassis tremelloides Berk. Oak Stump on hill near laboratory, C. S. H.—G. C. F.

COLEOSPORIACEAE.

Coleosporium solidaginis (Schw.) Thuem. On *Solidago sempervirens,* C. S. H.—M. A. B.

CORTICIACEAE.

Stereum compactum Pers. Road to Huntington, C. S. H.—M. A. B.

Stereum complicatum Fr. Frequent throughout island. —Jelliffe.

Stereum frustulosum Pers. Frequent throughout island. —Jelliffe.

Stereum hirsutum (Willd.) Pers. Lake region and DeForest Estate, C. S. H.—M. A. B.

Stereum striatum Fr. On chestnut Bark. Road to Huntington, C. S. H.—M. A. B.

Stereum versicolor Fr. Frequent throughout Island—Jelliffe.

Sterigmatocystis sp. On horse chestnut bur. C. S. H.—M. A. B.

EXOBASIDIACEAE.

Corticium comedans (Nees) Fr. On cherry birch. C. S. H. —M. A. B.

Hirneola auricula—Judae. (L) Berk. C. S. H.—M. A. B.

HYDNACEAE.

Hydnum adustum. Schw. Rotten wood. West of first lake. C. S. H.—N. M. G.

Hydnum Caput-Ursi Fr. C. S. H. vicinity—N. M. G.

Hydnum repandum L. C. S. H.—A. F. B.

Hydnum zonatum. Batsch. Ground vicinity first lake.

Irpex cinnamomeus Fr. Woods near school house on dead branches. C. S. H.—G. C. F.

Irpex deformis Fr. Woods near lakes, C. S. H.—M. A. B.

Irpex fusco violaceus (Schr.) Fr. Near Lakes, on birch bark. C. S. H.—M. A. B.

Irpex tulipiferae. Schw. Woods back of DeForest Estate on old twigs. C. S. H.—M. A. B.

Phaeodon imbricatus (L.) Schrot. On ground west of 2nd lake, C. S. H.—G. C. F.

LYCOPERDACEAE.

Bovistella ohiensis E. and M. Goat Pasture, C. S. H.—G.C.F.

Geaster hygrometricus. Pers. Sand beach near Bayville, C. S. H.—M. A. B.

Lycoperdon cyathiforme Bosc., C. S. H.—M. A. B.

Lycoperdon gemmatum Batsch. Soil in woods, C. S. H.—M. A. B.

Lycoperdon piriforme Schaeff. Common.—Jelliffe.

MELAMPSORACEAE.

Caeoma erigonatum S. On *Erigeron* sp., C. S. H.—A. F. B.

Caeoma nitens (Schw.) New. C. S. H.—A. F. B.

Calyptospora goeppertiana Kuhn. On *Vaccinium corymbosom*, forming witches brooms. C. S. H.—A. F. B.

NIDULARIACEAE.

Crucibulum vulgare Tul. Common on twigs and earth near lakes, C. S. H.—A. F. B.

Cyathus hirsutus (Schaeff) Duf. Hoffman. On logs, C. S. H.—A. F. B.

Cyathus sp. (Hall) Roadside, on earth and old horse dung. C. S. H.—A. F. B.

PHALLACEAE.

Dictyophora duplicata (Bosc) Ed. Fisch. C. S. H.—A. F. B.
Dictyophora phalloidea Desv. Frequent, L. I.—Jelliffe.
Mutinus bovinus Morg. Glen Cove, L. I.—Jelliffe.
Mutinus caninus (Huds.) Fr. Frequent on soil near laboratory.
Mutinus elegans Mont. Under old leaves chestnut woods, Huntington road. C. S. H.—D. S. J.
Phallus impudicus L. Infrequent throughout the island. —Jelliffe.
Rhytisma acerninum (Pers.) Fr. Frequent throughout L. I.—Jelliffe.
Rhytisma Solidaginis (Schw) Fr. Frequent throughout L. I. —Jelliffe.

POLYPORACEAE.

Boletus alveolatus B. and C. Frequent rich woods. C. S. H. —M. A. B.
Boletus americanus Pk. Woods south of Syosset Rd. C. S. H.—M. A. B.
Boletus auripes Pk. Huntington Road. C. S. H.—M. A. B.
Boletus auriporus Pk. C. S. H.—M. A. B.
Boletus bicolor (Pk.) Ground C. S. H.—M. A. B.
Boletus castaneus (Bull.) Woods. Road to Huntington, C. S. H.—M. A. B.
Boletus felleus (Bull.) Woods, near lakes. C. S. H.—D. S. J.
Boletus Frostii. (Russell.) Common in woods, south side Syosset Rd., C. S. H.—N. M. G.
Boletus gracilis (Beck) P. Henn. Woods, south side Syosset Road. C. S. H.—N. M. G.
Boletus griseus Frost. Ground. West side second lake, C. S. H.—M. A. B.
Boletus indecisus. (Pk.) Woods west of 2nd lake. C. S. H. —M. A. B.
Boletus ornatipes Pk. Open woods. Hill to Huntington. 2nd lake, C. S. H.—D. S. J.
Boletus russelli Frost. Open woods. Huntington Rd. C. S. H.—D. S. J.

Cyclomyces greene Berk. Soil in woods near lake. C. S. H. D. S. J.

Daedalea confragosa. (Bolt) Pers. Old stump. Sagamore Hill. C. S. H.—M. A. B.

Daedalea quercina. (L) Pers. Oak and chestnut stumps. Lakes. Huntington Road, C. S. H.—M. A. B.

Daedalea unicolor (Bull.) Fr. Frequent throughout the island.—Jelliffe.

Favolus europaeus Fr. Not infrequent. L. I.—Jelliffe.

Fistulina hepatica Fr. Frequent on chestnut, C. S. H.—M. A. B.

Fistulina pallida. B. and R. DeForest Estate. White oak stump, C. S. H.—M. A. B.

Fomes applanatus (Pers.) Wallr. Common on fallen logs. C. S. H.—M. A. B.

Lenzites Betulina (L.) Fr. Frequent throughout island. —Jelliffe.

Lenzites bicolor Fr. Glen Cove.—Jelliffe.

Lenzites sepiaria Fr. On telegraph pole near village, C. S. H. —M. A. B.

Polyporus betulinus (Bull.) Fr. On *Betula populifolia* near Huntington Road. C. S. H.—A. F. B.

Polyporus cinnabarinus. (Jacq.) Fr. Covering a fallen log near sandpit. C. S. H.—M. A. B.

Polyporus dryophilus (Berk.) (*C and de Not.*) On rotten wood. C. S. H.—N. M. G.

Polyporus flavo-virens. B. and Rav. Ground near Oyster Bay, C. S. H.—N. M. G.

Polyporus lucidus. Fr. On Hempstead plain; Hicksville. Stumps. C. S. H.—M. A. B.

Polyporus obliquus. Pers. Old log to left of sandspit. C. S. H.—M. A. B.

Polyporus pubescens (Sch.) Fr. Beech log, C. S. H.—M.A.B.

Polyporus robiniophilus Fr. Old locust tree near village. C. S. H.—M. A. B.

Polyporus sulphureus (Bull.) Fr. Old logs. Stumps, C. S. H.—D. S. J.

Polystictus abietinus (Dick) Fr. Old limb. C. S. H.—M.A.B.
Polystictus cinnabarinus (Klotz) Fries. On chestnut posts near rectory, C. S. H.—D. S. J.
Polystictus cinnamoneus Jacq. Mossy ground near Tiffanys. C. S. H.—M. A. B.
Polystictus connatus Schw. Woods west of lakes. C. S. H. —A. F. B.
Polystictus hirsutus (Wulf.) Fr. Stumps, C. S. H.—M. A. B.
Polystictus pargamenus Fr. Old stumps. C. S. H.—M. A. B.
Polystictus perennis (L.) Fr. West of lakes in the woods, C. S. H.—A. F. B.
Polystictus versicolor, (L.) Fr. Old logs. Road to Eugenics Record Office. C. S. H.—M. A. B.
Poria sp. Old twigs. C. S. H.—M. A.B .
Simblum rubescens Gerard.—Jelliffe.
Simblum sphaerocephalum Schlecht. Near Jones residence. C. S. H.—N. M. G.
Strobilomyces strobilaceus. Scop ex. Berk. Frequent in woods, C. S. H.—G. C. F. and A. F. B.
Trametes cinnabarina. Fr. C. S. H.—D. S. J.
Trametes sepium. B and C. Not uncommon through Island. —Jelliffe.

PUCCINIACEAE.

Aecidium Caladii. Frequent throughout island.—Jelliffe.
Aecidium fraxini. Schw. On ash trees.
Gymnosporangium globosum Farl. Aecidial stage on *Crataegus* sp. Mathesons Estate. C. S. H.—M. A. B.
Gymnosporangium juniperi-virginiae Schw. On juniper and apple trees. C. S. H.—M. A. B.
Gymnosporangium macropus Lk. Common on Juniper, C. S. H.—D. S. J.
Gymnosporangium Sabinae (Dicks) Winter. Frequent throughout island.—Jelliffe.
Puccinia Compositorum Schw. Glen Cove. L. I.—Jelliffe.
Puccinia graminis P. Abundant on grass. C. S. H.—A. F. B.
Puccinia Hieracii (Schw.) Mart. Glen Cove, L. I.—Jelliffe.
Puccinia Xanthii Schw. Frequent throughout island.—Jelliffe.
Uredo Potentillorum Oc. Common throughout island—Jelliffe.

Uromyces fragarioldes ? On *Duchesnia* near Laboratory, C. S. H.—M. A B.

Uromyces Lespedezae. Schw. Frequent throughout island.—Jelliffe.

Uromyces polygoni (Pers.) Fckl. On *Polygonum aviculare,* C. S. H.—A. F. B.

Uromyces statices B. & C. on *Statice limonium* at Lloyd's Neck. C. S. H.—A. F. B.

SCLERODERMATACEAE.

Scleroderma vulgare Horn. C. S. H.—M. A. B.

SPHAEROBALACEAE.

Sphaerobolus carpobolus L. (T.) Rotten logs near 1st lake. C. S. H.—D. S. J.

THELEPHORACEAE.

Craterellus cornucopoides L. ex. Pers. Gregarious on ground. C. S. H.—M. A. B.

Craterellus sinuosus Fr. var. *crispus.* On ground in woods at Tiffany's. C. S. H.—M. A. B.

Hymenochaete rubiginosm (Dicks.) Lev. C. S. H.—D. S. J.

Michinera Artocreas B. & C. C. S. H.—N. M. G.

Solenia villosa Hoffm. On decaying branches of *Rubus* near school house. G. S. H.—M. A. B.

TILLETIACEAE.

Entyloma rhodopolium (Fr.) Quel. DeForest Estate. C.S.H. —M. A. B.

TREMELLACEAE.

Exidia glandulosa (Bull.) Fr. Common on dead twigs. C. S. H.—M. A. B.

Tremella vesicaria. Eng. Bot. On rotten branches nad Ground near school house.—G. C. F.

Ulocalla foliacea (Pers) Bref. Dead branches. West of 2nd Lake. C. S. H.—G. C. F.

USTILAGINACEAE.

Graphiola Phoenicis (Moug.) Post. On cultivated palms. C. S. H.—M. A. B.

Ustilago zeae (Backm.) Ung. On corn in Matheson's Garden. C. S. H.—M. A. B.

FUNGI IMPERFECTI

DEMATIACEAE.

Alternaria tenuis. Nees. On dung culture. C. S. H.—A. F. B.
Sporodesmium sp. Rotten log 1st lake. C. S. H.—N. M. G.

MUCEDINACEAE.

Amblyosporium alboluteum Cost. Woods near school house. C. S. H.—A. F. B.
Botrytis cinerea. Pers. On leaves of *Symplocarpus foetidus.* C. S. H.—A. F. B.
Cephalothecium roseum Corda. On decaying wood. C. S. H. —A. F. B.
Cercospora symplocarpi Peck. On *Symplocarpus foetida.* C. S. H.—A. F. B.
Mycogone incarnata. Pers. On decaying *Agaricus.* C. S. H. A. F. B.
Rhinotrichum (Corda) sp. On cherry bark. C. S. H.—A.F.B.
Sepedonium chrysospermum (Bull) Fries. Parasitic on *Boletus* sp. near fish hatchery. C. S. H.—A. F. B.
Stachybotrys lobulata Corda. On goat dung. Lloyd's Neck. C. S. H.—A. F. B.

SPHAERIOIDACEAE.

Darluca Filum (Biv.) Cast. Not infrequent.—Jelliffe.
Phyllosticta acericola C. and B. On *Acer rubrum.* DeForest Estate. C. S. H.—M. A. B.
Phyllosticta catalpae. E. and M. Havemeyer's Estate on *Catalpa* sp. C. S. H.—M. A. B.
Phyllosticta smilacis. E. and E. On *Smilax glauca.* C. S. H. —M. A. B.
Phyllosticta syringae Westend. On *Syringa vulgaris.* C. S. H.—M. A. B.
Phyllosticta terminalis. E. and M. On *Leucothöe.* C. S. H. —M. A.B.
Septoria Kalmicola Fries. Common on *Kalmia.* C. S. H. — D. S. J.

STILBACEAE.

Isaria sp. On Cocoon. C. S. H.—A. F. B.

TUBERCULARIACEAE.

Fusarium roseum Lk. Not infrequent.—Jelliffe.

Tubercularia vulgaris Tode. Common throughout.—Jelliffe.

LICHENES.*

CLADONIACEAE.

Baeomyces roseus Pers. 3d lake,C. S. H.—N. M. G.

Cladonia coccifera Willd. Fl. Berol. On ground W. of 3d lake. C. S. H.—S. A. G.

Cladonia cristatella Tuck. On ground W. of 3d lake, C. S. H.—S. A. G.

Cladonia fimbriata (L.) Fr. Frequent on Iong Island. — Jelliffe.

Cladonia furcata (Huds.) Fr. Frequent on Long Island. — Jelliffe.

Cladonia gracilis verticillata Fr. W. of 3d lake, C. S. H. — S. A. G.

Cladonia papillaria (Ehrb.) Hoffmann. Port Jefferson, L. I. —Wood.

Cladonia rangifering Web. On ground W. of 3d lake. C. S. H.—S. A. G.

Cladonia pyxidata (L) Fr. W. of 3d lake. C. S. H.—S. A. G.

Cladonia pyxidata epiphylla Hoffm. Hempstead Plain, Hicksville, L. I.—Harper, '12.

Cladonia squamosa Hoffm. On ground W. of 3d lake—S.A.G.

Stereocaulon condensatum Hoffm. On ground. C. S. H. — S. A. G.

GRAPHIDACEAE

Buellia pullata Tuck. Port Jefferson, L. I.—Wood.

---

* Revised according to nomenclature given in "British Lichens," A. L. Smith, British Museum of Natural History.

For other lichens which may eventually be collected at Cold Spring Harbor see Burnham and Lathan, *loc cit.*, "Additions to the Lichen Flora of Long Island" Wood G. C. *Bryologist* 8. "A Preliminary List of the Lichens found within a radius of 100 miles of N. Y. City," Wood. G. C. *Torreya* 14.

LECIDEACEAE.

Lecidea parasema (Ach.) Th. Fr. Frequent on Long Island. —Jelliffe.

Graphina anguina Muell.-Arg. Frequent on Long Island. — Jelliffe.

Graphina anguina var. *graciliens*. Nyl. C. S. H.—Wood.

PARMELIACEAE.

Cetraria aurascens Tuckm. On Trees. C. S. H.—Wood.

Cetraria lacunosa Ach. On Trees. C. S. H.—Wood.

Evernia furfaracea Mann. Lich. Bohem. C. S. H.—Wood.

Leconora subfusca (L.) Ach. Research wharf, C. S. H.— D. S. J. and H. H. Y.

Lobaria pulmonaria (L) Ach. Common throughout island. —Jelliffe.

Parmelia caperata (L) Ach. Common throughout island.— Jelliffe.

Parmelia perforata (Jaeg.) Ach. C. S. H., on trees.—Wood.

Parmelia saxitilis Ach. Meth. Lich. 3d lake, C. S. H.—S.A.G.

Parmelia saxitilis var. *sulcata* Ngl. C. S. H. on trees. — Wood.

Ramalina calicaris (L.) Fr. Common throughout island.— Jelliffe.

Usnea barbata Web. Common throughout island—Jelliffe.

Usnea barbata var. *florida* (Fr.) C. S. H. on trees—Wood.

PHYSCIACEAE.

Physcia orbicularis. Dalla Torre and Smith. On rocks, C. S. H.—Wood.

Physcia stellaris. Nyl. Frequent throughout island.—Jelliffe.

Pyxine sorediata Fr. On Trees. C. S. H.—N. M. G.

Theloschistes chrysophthalmus. Th. Fr. Gen. Het. Frequent. —Jelliffe.

HEPATICAE.†

ANTHOCEROTACEAE.

**Anthoceros Laevis* L.

**Nothothylas orbicularis* (Schwein) Sulliv.

CEPHALOZIACEAE.

Bazzania trilobata (L) S. F. Gray. Foot of tree, vicinity of 1st lake. C. S. H.

**Calypogeia sphagnicola* (Arn and Perss.) Wernst & Loeske.

**Calypogeia Sullivantii* Aust.

Calypogeia Trichomanis (L) Corda. On ground at head 1st lake. D. S. J.

Cephalozia curvifolia (Dicks) Lindb. On rotten wood near 1st lake.—D. S. J.

**Cephalozia fluitans* (Nees) Spruce.

**Cephalozia Francisci* (Hook) Dumort.

**Cephalozia macrostachya* Kaal.

**Cephalozia media* Lindb.

**Lepidozia setacea* (Web.) Mitt.

**Oddontoschisma prostratum* (Sw.) Trevis.

**Odontoschisma Sphagni* (Dicks) Dumort.

LEJEUNACEAE.

**Frullania Asagrayana* Mont.

Frullania eboracensis Gottsche. Not infrequent on trees. Long Island.—Jelliffe.

---

† Nomenclature that of the "Second Revised List of New England Hepaticae;" A. W. Evans, (Rhodora 25). I am indebted to Dr. Evans for aid in revising this portion of the manuscript.

* Indicates species listed by Burnham and Latham from the vicinity of Southold and Gardiners Island (Torreya 14). These species may be expected to occur further along the north coast in the vicinity of Cold Spring Harbor.

LOPHOZIACEAE.

Chiloscyphus polyanthos (L) Corda. Near 1st and 2nd lakes. C. S. H.—D. S. J.

Chiloscyphus rivularis (Schrad.) Loeske. Near 1st and 2nd lakes. C. S. H.—D. S. J.

Lophocolea heterophylla (Schrad.) Dumort.

**Lophocolea minor.* Nees.

MARCHANTIACEAE.

Conocephalum conicum (L) Du Mort. Common throughout the island.—Jelliffe.

Marchantia polymorpha L. Fish Hatchery Ponds. C. S. H. —N. M. G.

PELLIAÇEAE.

**Fossombronia foveolata* Lindb.
**Pellia epiphylla* (L.) Carda.
**Pellia Fabroniana* Raddi.

PORELLACEAE.

**Porella pinnata* L.
**Porella platyphylla* (L) Lindb.
Porella platyphylloidea (Schwein) Lindb. Frequent throughout island.—Jelliffe.

PTILIDACEAE.

**Ptilidium pulcherrimum* (Web.) Hampe.

RADULACEAE.

**Radula complanata* (L) Dumort.

REBOULIACEAE.

**Asterella tenella* (L) Beauv.

RICCARDIACEAE.

Pallavicinia Lyelli (Hook) S. F. Gray. Fern Belt. Salt Marsh vicinity 1st lake. C. S. H.—D. S. J.
Riccardia multifida (L) S. F. Gray. C. S. H.—D. S. J.
**Riccardia pinguis* (L) S. F. Gray. C. S. H.—D. S. J.
Riccardia sinuata (Dicks) Lindb. C. S. H.—D. S. J.

RICCIACEAE.

**Riccia fluitans* L.
**Riccia Sullivantii* Aust.
Ricciocarpus natans (L) Corda. Between 1st and 3d lakes. C. S. H.—D. S. J.

MUSCI.*

BARTRAMIACEAE.

Bartramia pomiformus (L) Hedw. C. S. H.—Grout.
Philonotis fontana (L.) Brid. Huntington, L. I.—Jelliffe.

---

* Nomenclature that of the "Mosses of western Pennsylvania, O. E. Jennings. Published by the author, Pittsburgh, Pa. Dr. Jennings has kindly checked this list with records of his own from Cold Spring Harbor vicinity.

BRACHYTHECIACEAE.

Brachythecium acuminatum (Hedw.) Kindb. C. S. H. vicinity.—N. M. C.

Brachythecium flagellare (Edw.) Jennings. Bryol. Europ. Frequent.—O. E. J.

Brachythecium rivulare (Bruch) Centreport, L. I.—Jelliffe.

Cirriphyllum Boscii (Schw.) Grout. Frequent L. I.—O. E. J.

Eurynchium pulchellum (Hedw.) Jennings. Northport. L. I. —Jelliffe.

Oxrhynchium hians (Hedw.) Jennings. Northport. L. I. — Jelliffe.

Rhynchostegium serrulatum (Hedw.) Jaeger. Frequent, L. I. —Jelliffe.

BRYACEAE.

Bryum argenteum (L) Hedw. Common throughout.—O. E. J.

Bryum caespiticium (L) Hedw. Northport, L. I.—Jelliffe.

Leptobryum pyriforme (L) Schimp. Lloyd's Neck, L. I. — Jelliffe.

BUXBAUMIACEAE.

Diphyscium foliosum (Web.) Mohr. Centreport, L.I.—Jelliffe.

CLIMACEAE.

Climacium americanum Brid. Not infrequent, L. I.—Jelliffe.

DICRANACEAE.

Ceratodon purpurascens (Hedw.) Brid. Not infrequent, L. I.—Jelliffe.

Dicranella heteromalla (L) Schimp. Common throughout. —O. E. J.

Dicranella varia (Hedw.) Schimp. Northport.—Jelliffe.

Dicranum flagellare Hedw. Not infrequent throughout. — Jelliffe.

Dicranum longifolium (Ehr.) Hedw. C. S. H.—N. M. G.

Dicranum montanum Hedw. Northport, L. I.—Jelliffe.

Dicranum scoparium (L) Hedw. Frequent on L. I.—Jelliffe.

Dicranum spurium, Hdw. Huntington, L. I.—Jelliffe.

Ditrichum pallidum (Schreb.) Hamp. Not infrequent, L. I. —Jelliffe.

Ditrichum tortile (Schrad.) Linds. Huntington, L. I. Jelliffe.

Pleuridium alternifolium (Dicks) Rab. Glen Cove, L. I.—Jelliffe.

ENTODONTACEAE.

Entodon cladorrhizans (Hedw.) G. Mueller. C. S. H.—N.M.G.
Platygerium repens (Brid.) Bryol Europ. Northport, Jelliffe.
Pylaisia schimperi R. and C. On apple trees, C. S. H. —Grout.

FONTINALACEAE.

Dichelyma capillaceum (Dill.) Bryol. Europ. Northport, L. I.
Fontinalis antipyretica L. 1st and 2nd lakes. C. S. H.—O.E.J.
Fontinalis antipypretica var. *gigantea* Sull. 1st and 2nd lakes. C. S. H.—J. A. H.

FUNARIACEAE.

Funaria hygrometrica (L.) Sibth. Not infrequent L. I.—Jelliffe.
Physcometrium Pyriforme L. Glen Cove, L. I.—Jelliffe.

ORTHOTRICHACEAE.

Drummondia clavellata Hook. Lloyd's Neck, L. I.—Jelliffe.
Orthotrichum Braunii Bry. Eur. Centreport, L. I.—Jelliffe.

POLYTRYCHACEAE.

Catharinea angustata Brid. Frequent, L. I.—Jelliffe.
Catharinea undulata (L.) Web. and Mohr. Frequent L. I.—Jelliffe.
Pogonatum pennsylvanicum (Hedw.) Paris. Frequent L. I. —O. E. J.
Polytrichum commune L. C. S. H. vicinity.—N. M. G.
Polytrichum Juniperinum Willd. C. S H. vicinity.—O. E. J.
Polytrichum Ohioense R. and C. C. S. H. vicinity.—G. H. H.

SPHAGNACEAE.

Sphagnum capillifolium (Ehr.) Russ, and Warn. Not infrequent, L. I.—Jelliffe.
Sphagnum latifolium Hedw. Not infrequent, L. I.—Jelliffe.
Sphagnum molle Sull. Northport, L. I.—Jelliffe.

TORTULACEAE.

Weisia viridula (L) Hedw. Common throughout.—O. E. J.

HEDWIGIACEAE.

Hedwigia ciliata Ehrb. Bryol. Europ. Northport.—Jelliffe.

HYPNACEAE.

Amblystegium adnatum (Hedw.) Br. and Sch. Northport.—Jelliffe.

Amblystegium riparium (L) Br. and Sch. Frequent, L. I.—Jelliffe.

Campylium hispidulum (Brid) Martin. Centreport, L. I.—Jelliffe.

Hylocomium splendens (Hedw.) Bryol. Europ. Northport.—Jelliffe.

Isopterygium turfaceum (Lind.) Northport. L. I.—Jelliffe.

Plagiothecium sylvaticum (Huds) Bryol. Eur. Centreport, L. I.—Jelliffe.

Stereodon cupressiforme (L) Brid. Not infrequent, L. I.—Jelliffe.

Steredon haldanianus (Grev.) Lindb. Frequent, L. I.—Jelliffe.

Stereodon imponens (Hedw.) Brid. Frequent, L. I.—Jelliffe.

LESKEACEAE.

Elodium Paludosum (Sull.) Loeske. Centreport, L. I.—Jelliffe

Haplocladium virginianum (Bridel.) Brotherus. Lloyd's Neck, L. I.—Jelliffe.

Thelia asprella (Schimp) Sull. On tree, C. S. H.—D. S. J.

Thelia hirtella (Hedw.) Sull. Frequent throughout, L. I.—Jelliffe.

Thuidium delicatulum (L) Mitt. Frequent on L. I.—O. E. J.

LEUCOBRYACEAE.

Leucobryum glaucum (L) Schimp. Not infrequent Long Island.—Jelliffe.

MNIACEAE.

Mnium affine Bland. Common throughout L. I.—O. E. J.

Mnium cuspidatum (L.) Leys. 1st and 2nd lake regious. C. S. H.—N. M. G.

BOOK REVIEWS

In this section are reviews of new, or particularly important and interesting books in the fields of natural science. Books dealing with botany or kindred subjects should be sent to the Editor, the University of Notre Dame. *All other books for review* should be sent to Carroll Lane Fenton, at the Walker Museum, the University of Chicago, Ill. Publishers are requested to furnish prices with books.

HOUSE, HOMER D., ANNOTATED LIST OF THE FERNS AND FLOWERING PLANTS OF NEW YORK STATE.

While opinions as to the status of genera and species may vary with different individuals, every one can not be delighted, whatever his views, when even rejected genera are classified in such a way in a work that all may easily be seen how things are correlated. The author is rather conservative in his views, yet the most radical "genus splitter" can not but admire the wealth of references that point to a most thorough treatment of the subject. Seldom, too, does one see in a botanical work this admirable lack of bias and personal prejudices of an author. With views decisively his own, the writer of the flora includes references and a wealth of information that the ordinary other hide-bound views of books of a decade or two past have failed to give, or purposely sought to belittle or conceal with a prejudicial attitude of mind which is unscientific.

The Flora of the State of New York is a work that will be consulted and studied long after our time, because it is thoroughly scientific. The State of New York, notable as having published many valuable botanical works heretofore, is to be congratulated on another scholarly, and erudite work; and the men of sicence of this country have been led to expect the best from the empire state and seldom, if ever, have been disappointed. No botanist of this country can afford to be without this valuable publication.—J. A. N.

The American Midland Naturalist

PUBLISHED BI-MONTHLY BY THE UNIVERSITY
OF NOTRE DAME, NOTRE DAME, INDIANA

VOL. IX. MARCH, 1925. NO. 7 8

THE NAIAD-FAUNA OF THE TENNESSEE RIVER SYSTEM BELOW WALDEN GORGE

BY DR. A. E. ORTMANN

The present paper is a contribution to a general study of the "Cumberlandian" Naiad-fauna, which has for its final object the reconstruction of the ancient drainage features of the southern Appalachians and the Cumberland Plateau. It is a sequence to several previous publications (Ortmann, '18, '23-'24, '24).

In the paper of '24, I have tried to define the term "Cumberlandian" Naiad-fauna, and in the present paper it will be my chief aim to point out those forms which belong to this fauna in the drainage of the *lower Tennesee, below the Walden Gorge at Chattanooga.* As will be seen, there is, in this region, a mixture of Cumberlandian elements with others, which belong to the "Interior Basin," and have their center of dispersal in the lower Ohio and its vicinity.

The necessity of such a study, and of a synopsis of the Naiad-fauna of the lower Tennessee, becomes very obvious, when we consider that the most famous and unique locality in these parts, the "Mussel-Shoals," is now on the best way to be utterly destroyed by the construction of the "Wilson dam" (see: Science, Dec. 19, '24, pp. 565, 566). No complete list of the shells of this region has ever been published, although a number of scattered and fragmentary notes is on hand. The Tennessee River *below* the Mussel-Shoals was hitherto unknown.

The Carnegie Museum possesses a large amount of unpublished material from this region, obtained in various ways, which gives a rather full representation of this fauna,

so that only in very few cases I have to rely exclusively upon other authorities. In a number of cases, I also have the advantage of having examined the collection of B. Walker in Detroit, which contains a wealth of valuable material, and I am under great obligations to Mr. Walker for the privilege of using the information thus obtained in the present paper.

The following list of localities will give an idea of the character of the material at hand.

LIST OF LOCALITIES.

Tennessee River, Trotters Landing, Dixie, Humphreys Co., Tenn.

Material in Car. Mus. collected by the writer, Aug. 20, '24. This is the only known locality for Naiades *below* the Mussel Shoals.

The river at this place is large, in mature stage, flowing steadily over a gravel-bottom in the main channel. The banks are largely muddy. Most of the shells were obtained from the piles of clam-diggers.

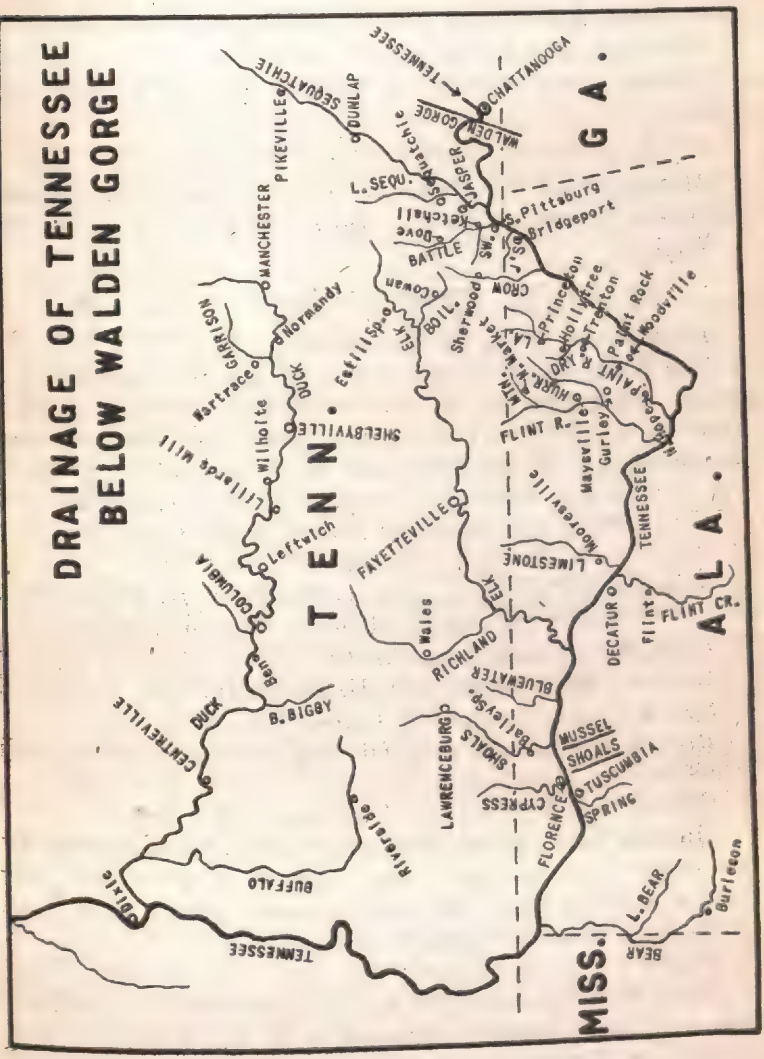
Tennessee River, Tuscumbia, Colbert Co., and *Florence, Lauderdale Co., Ala.*

These are the "Mussel-Shoals," lying mostly several miles above Florence, but they practically form one and the same locality, with the same ecological conditions.

Older records from these parts have been furnished by Conrad, Lea, and Call. More recently ('06), Hinkley has published a list of forms collected by himself in the fall of 1904. The Carn. Mus. has material from various sources, obtained by donation or purchase from the collections of W. D. Hartman, H. H. Smith, V. Sterki, and B. Walker, but mostly collected by H. H. Smith (1904-1910), and donated by G. H. Clapp.*)

Finally, the present writer has collected here on Aug. 26, 1924, between the Florence bridge and Wilson Dam. At this

* The collections made by H. H. Smith in Alabama and surrounding parts have been divided between the University of Alabama, Mr. B. Walker, and Mr. Geo. H. Clapp. Mr. Clapp has turned over his share to the Carnegie Museum, for which generous gift the Museum is greatly obliged to him.


DRAINAGE OF TENNESSEE
BELOW WALDEN GORGE
TENN.
GA.
ALA.
MISS.
TENNESSEE
CHATTANOOGA
WALDEN GORGE
SEQUATCHIE
DUNLAP
PIKEVILLE
MANCHESTER
L. SEQU.
JASPER
S. Pittsburg
Bridgeport
Ketchall
Dove
BATTLE
SW.
J'S.
CROW
Princeton
Hollytree
Trenton
Paint Rock
Woodville
Cowan
BOIL.
Sherwood
ELK
Estill Sp.
Normandy
GARRISON
Wartrace
DUCK
SHELBYVILLE
Wilhoite
Lillards Mill
Leftwich
COLUMBIA
Ben
B. BIGBY
CENTREVILLE
DUCK
Riverside
BUFFALO
Dixie
TENNESSEE
FAYETTEVILLE
Wales
RICHLAND
ELK
LIMESTONE
Mooresville
Maysville
Gurley
FLINT R.
DRY
HURR.
PAINT R.
Mapes
TENNESSEE
DECATUR
Flint
FLINT CR.
BLUEWATER
Bailey Sp.
SHOALS
LAWRENCEBURG
CYPRESS
FLORENCE
MUSSEL
SHOALS
TUSCUMBIA
SPRING
L. BEAR
BEAR
Burleson

place the river has a good current over rocks and gravel, but on the banks there is a good deal of mud in quiet eddies. Most of the shells found were dead (muskrat-material.)

Tennessee River, Decatur, Morgan Co., Ala.

Hinkley ('04) reports a number of shells from this locality.

Tennessee River, Bridgeport, Jackson Co., Ala.

Material from this place has been examined in the Walker collection. Several forms are also in the Carn. Mus., donated by Walker.

TRIBUTARIES

Duck River system in Tennessee.

The Naiad-fauna of this drainage has been treated in a special publication by the writer (Ortmann, '24). Being a tributary of the lower Tennessee, this river has also been considered in the present paper in a general way, but it was unnecessary to go into details. The material has been mostly collected by the writer and is in the Carn. Mus.

Bear Creek, Burleson, Franklin Co., Ala.

Material in the Carn. Mus. collected by H. H. Smith; a few additional forms examined in the Walker collection.

Little Bear Creek, Franklin Co., Ala.

In Carn. Mus. collected by H. H. Smith.

Spring Creek, Tuscumbia, Colbert Co., Ala.

Records by Call are at hand, and material has been seen in the Walker collection.

Cypress Creek, Florence, Lauderdale Co., Ala.

Material seen in the Walker collection, and collected by the writer Aug. 24, '24. The creek is of good size, with rocky-gravelly bottom, and swift current. Shells were found on the edge of water-willows (*Dianthera.*)

Shoals Creek, Lauderdale Co., Ala.

Shells have been reported by Hinkley ('06). In the Carn. Mus. is a large material collected by H. H. Smith, and some donated by Walker.

No exact locality is given, but probably the lower part of the creek is meant.

Shoals Creek, Bailey Springs, Lauderdale Co., Ala.

Material in Carn. Mus. collected by the writer Aug. 25, 1924.

Shells in rocky riffles, chiefly at the upper end; some along the edge of waterwillows.

Shoals Creek, Lawrenceburg, Lawrence Co., Tenn.

In Carn. Mus., collected by the writer, Sept. 1, 1923.

Among water willows, in riffles.

Bluewater Creek, Lauderdale Co., Ala.

Material in Carn. Mus. collected by H. H. Smith; some additional forms seen in Walker collection.

Lower Elk River, Limestone Co., Ala.

Records given by Conrad and Call are used, as well as material seen in the Walker collection.

This is in the lower part, near the mouth of Elk River, but without exact locality.

Elk River, Fayetteville, Lincoln Co., Tenn.

Mostly in Carn. Mus. collected by H. H. Smith, but also in Walker collection, from the same source.

Elk River, Estill Springs, Franklin Co., Tenn.

In Carn. Mus., collected by H. H. Smith.

Richland Creek, Wales, Giles Co., Tenn. (to Elk R.)

In Carn. Mus., collected by the writer Aug. 31, '23.

In riffle along a gravel bar.

Boiling Fork, Cowan, Franklin Co., Tenn. (to Elk R.)

In Carn. Mus., collected by H. H. Smith.

Flint Creek, Morgan Co., Ala.

Reported by Conrad without exact locality, but probably above the next locality. This is the Flint *River* of Conrad, different from Flint River in Madison Co., see below.

Flint Creek, Flint, Morgan Co., Ala.

In Carn. Mus., collected by the writer Aug. 28, '24.

The creek is sluggish here, and, although flowing between banks partially composed of massive limestone rocks, has sandy-muddy bottom, with a corresponding fauna.

Limestone Creek, Mooresville, Limestone Co., Ala.

Material examined in Walker collection.

Flint River, Gurley, Madison Co., Ala.

Mostly in Carn. Mus., collected by H. H. Smith; some in Walker collection from the same source.

Flint River, Maysville, Madison Co., Ala.
In Carn. Mus., collected by H. H. Smith.

Hurricane Creek, Gurley, Madison Co., Ala., (to Flint R.)
In Carn. Mus., collected in part by H. H. Smith, in part by H. E. Wheeler, Sept. 13, '10; a few additional forms in Walker collection.

Mountain Fork, New Market, Madison Co., Ala. (to Flint R.)
In Carn. Mus., collected by H. E. Wheeler, August '10.

Paint Rock River, New Hope, Madison Co., Ala.
In Carn. Mus., collected by H. H. Smith.

Paint Rock River, Woodville, Jackson Co., Ala.
Reported by Simpson ('14).

Paint Rock River, Paint Rock, Jackson Co., Ala.
In Carn. Mus., collected by H. H. Smith; also in Walker collection.

Paint Rock River, Trenton, Jackson Co., Ala.
In Carn. Mus., collected by H. H. Smith.

Paint Rock River, Holly Tree, Jackson Co., Ala.
In Carn. Mus., collected by H. H. Smith.

Paint Rock River, Princeton, Jackson Co., Ala.
In Carn. Mus., collected by H. H. Smith; also some material in Walker collection.

Dry Fork, Holly Tree, Jackson Co., Ala. (to Paint Rock River.)
Material examined in Walker collection.

Larkins Fork, Princeton, Jackson Co., Ala., (to Paint Rock R.)
In Carn. Mus., collected by H. H. Smith.

Crow Creek, Sherwood, Franklin Co., Tenn.
In Carn. Mus., collected by H. H. Smith.

Jones Creek, Bridgeport, Jackson Co., Ala.
In Carn. Mus., collected by H. H. Smith.

Battle Creek, South Pittsburgh, Marion Co., Tenn.
In Carn. Mus., collected by H. H. Smith.

Battle Creek, Dove, Marion Co., Tenn.
In Carn. Mus. and Walker collection, collected by H. H. Smith.

Sweden Creek, Ketchall, Marion Co., Tenn. (*to Battle Creek.*)

In Carn. Mus. collected by C. Goodrich, Sept. '23.

Sequatchie River, Jasper, Marion Co., Tenn.

In Carn. Mus., collected by C. Goodrich, Sept. '23; also in Walker collection, collected by Wetherby.

Sequatchie River, Dunlap, Sequatchie Co., Tenn.

In Walker collection, collected by C. C. Adams, and in Carn. Mus. collected by C. Goodrich, Sept. '23.

Sequatchie River, Pikeville, Bledsoe Co., Tenn.

In Carn. Mus. collected by C. Goodrich, Sept. '23.

Stream flowing from spring (*to Sequatchie*), *Jasper, Marion Co., Tenn.*

In Carn. Mus. collected by C. Goodrich, Sept. '23.

Little Sequatchie River, Sequatchie, Marion Co., Tenn.

In Carn. Mus. collected by C. Goodrich, Sept. '23.

In the following enumeration the above localities are given in an abridged form, easily understood. MS stands for Mussel-Shoals. I have marked records supported by material in the Carnegie Museum by an exclamation mark (!), and such records, which I secured or confirmed by my own collecting by a double exclamation mark (!!). Forms belonging to the "Cumberlandian Fauna" (Ortmann, '24 pp. 40-44) are marked with an asterisk (*).

ENUMERATION OF SPECIES AND VARIETIES, WITH REMARKS ON TAXONOMY AND DISTRIBUTION.

1. *Cumberlandia monodonta* (*Say*).—Ms (!!)—Sequatchie R., Jasper (!)

According to the considerable number of dead shells seen by myself at the Mussel-Shoals, this species must be, or have been, abundant at this place. Goodrich collected a single individual at Jasper. For the rest, it is not known from any other place in the lower Tennessee region.

This species seems to be most abundant in the Cumberland and Tennessee drainages, including the upper Tennessee. But it is also present in the lower Ohio, the lower Wabash, the Mississippi above Cairo, and the lower Illinois River, It

is also known from Osage River in Missouri (Utterback), and from Ouachita River in Arkansas (Wheeler). These latter localities are rather isolated, and seem to belong to different parts of the Ozark region. It is quite possible, that they indicate the former connection of the Ozarks with the Cumberland Plateau, before the Upper cretaceous Mississippi Embayment was formed. There are several other cases parallel to this.

2. *Fusconaia ebenus* (*Lea*).—Dixie (!!)—MS(!)—Decatur (Hinkley).

Found to be rather numerous at the first place; from the Mussel-Shoals I have only one specimen, rather typical, but small, collected by Smith. Hinkley mentions it from the same place and from Decatur. It is entirely absent from the upper Tennessee system (above Walden Gorge),* but is abundant in the lower Cumberland, going up to Wayne Co., Ky. It is common in the larger rivers of the Interior Basin, with a considerable extension of the range southward.

Thus it seems to belong to the latter region, and is a modern immigrant both in the Cumberland and Tennessee rivers.

3. *Fusconaia subtrotunda* (*Lea*).—Dixie (!!)—MS(!)—Bridgeport (Walker coll.)

This is known only from the main river. The specimens at hand have the dimaeter from 51 to 66 percent of the length, and thus represent the typical *subrotunda*.. One from Dixie has a length of 70 mm, and one from the Mussel-Shoals that of 88 mm. Thus they equal, and even considerably surpass the maximum size of *F. pilaris* of the upper Tennessee (Ortmann, '20 p. 309). I have repeatedly pointed out (Ortmann, '18 p. 527 and '20 p. 278), that the only difference of *pilaris* from *subrotunda* is the smaller size of the former. Thus it is absolutely impossible to distinguish younger *subrotunda* from *pilaris*, and we should unite both into *one* species. This requires a straightening out of the nomenclature of the headwaters-races of both, *subrotunda*

* It has been mentioned as from Holston and French Broad Rivers by Boepple and Coker ('12), but this surely rests on a misidentification of some form of the *F. pilaris* group of that region.

(*kirtlandiana*) and *pilaris* (*lesueuriana* and *bursa-pastoris*.) But this is simply a question of convenience and priority.

Thus *F. subrotunda* is found in the upper and lower Tennessee; it is in the Cumberland, and very abundant in the Ohio system. Its center of origin is obscure.

(*) 4. *Fusconaia cuneolus* (*Lea.*)—Bear Cr., Burleson (!)—Limestone Cr. Mooresville (Walker coll.)—Flint R. Maysville (!)—Hurricane Cr., Gurley (Walker coll.)—Paint Rock R., Paint Rock (!).

Found only in some of the tributaries of the lower Tennessee, but possibly overlooked in others. A small creek form, passing in the downstream direction into the more swollen *F. cuneolus appressa*. Specimens from Bear Cr., Limestone Cr., Hurricane Cr., and Paint Rock R. stand very close to the latter (dia. 48 and 49 percent of length), and have been found associated with it in Bear Cr., Limestone Cr., and Paint Rock R. Specimens from Maysville have the dia. of 43 and 45 percent, and thus are more typical *cuneolus*.

A Cumberlandian form, but restricted to the upper and lower Tennessee. Shells of this type are missing in Duck River, as well as in the whole Cumberland drainage.

(*) *Fusconaia cuneolus appressa* (*Lea*).—MS (Lea)—Bear Cr., Burleson (Walker coll.)—Flint Cr., Flint (!!)—Limestone Cr., Mooresville (Walker coll.)—Paint Rock R., Paint Rock (!).

The Mussel-Shoals (Tuscumbia; also "Tennessee and Holston Rivers") are the type-locality of this form, but I have seen no material from this place, unless the figured type of Lea, which I have seen in Washington, is from Tuscumbia, (concerning this type, see Ortmann, '18 p. 531). The diameter of this specimen is 52 per cent of the length. The synonym *U. tuscumbiensis Lea*, also from the Mussel-Shoals, has a diameter of 56 to 58 per cent (Ortmann, '20 p. 284). A specimen collected by myself in Flint Creek has the diameter of 57 per cent, and others from Paint Rock have 50 and 57 per cent. In the Walker collection are specimens from Mooresville with the diameter up to 63 per cent. All these thus represent this variety, which belongs to the larger rivers, also in the upper Tennessee drainage (Ortmann, '20

p. 284 ff). The fact that the specimen from Flint Creek was found in a small creek, but in smooth, sandy-muddy bottom, possibly indicates that not so much size of stream, as character of bottom and current determine the development of the "big -river-type."

The general distribution of *F. cuneolus appressa* is the same as that of *F. cuneolus*, with the exception that it prefers larger streams. It is also a Cumberlandian type, missing in Cumberland and Duck Rivers.

(*) 6. *Fusconaia edgariana* (*Lea*).—MS (Lea) (Hinkley)—Cypress Cr. Florence (Walker coll.)—Flint R., Gurley (Walker coll.)—Paint Rock R., Paint Rock (!)—Trenton (!).

The Mussel-Shoals are one of the type-localities of this form, but I have seen no specimens from them. It is also in the lower parts of the tributaries, which is most evident in Paint Rock River, where the large-river-form passes farther up into the small-river-type: *F. edgariana analoga* (see: Ortmann, '20 p. 287). A specimen from Cypress Creek (lower part) in the Walker collection has the diameter of 54 per cent, another one from Gurley has 52 per cent.

The general distribution of this Cumberlandian type is very similar to that of *F. cuneolus*. It is found in the upper and lower Tennessee, but is missing in Cumberland and Duck Rivers. The present form belongs to the larger rivers.

(*) 7. *Fusconala edgariana analoga* (Ortmann).—Paint Rock (!)—Trenton (!)—Princeton (!).

Known only from Paint Rock River. It has here the same relation to the main species as in the upper Tennessee (Ortmann, l. c.) It deserves mention that the *edgariana*-group has not been found in Bear Creek, Shoals Creek, and Elk River, but it is impossible to decide, whether it is positively missing, or has been only overlooked.

A Cumberlandian type, with the same general distributional features as the main species, but restricted to the headwaters.

(*Unio cor Conrad* has been described from "Elk and Flint Rivers" (Flint Creek). For a time it was believed by Frierson and Ortmann ('18 p. 532), that this is the same as *F. edgariana* (or a related form.) However, Ortmann and Walker ('22 p. 6), following Pilsbry, have kept it separated, as *F. cor*. If this is correct, *U. cor* has never

been found subsequently to its first description, and must be regarded as an unidentified or spurious species.) (See Note at the end of this paper, p. 371).

(*) 8. *Fusconaia barnesiana* (*Lea.*)—MS (Lea)—Middle Duck R. and tributaries (!!)—Bear Cr., Burleson (Walker coll.)—Spring Cr., Tuscumbia (Call) (Walker coll.)—Shoals Cr., Bailey Springs (!!)—Bluewater Cr. (!)—Elk R., Fayetteville (!)—Estill Springs (!)—Richland Cr., Wales (!!)—Limestone Cr., Mooresville (Walker coll)—Sequatchie R., Dunlap (Walker coll.)

Generally the form of rivers of medium size, but reported by Lea (as *meredithi* and *pudicus*) from the main river at the Mussel-Shoals. It is found in almost all tributaries: probably it is present everywhere under the proper conditions.

A Cumberlandian type, very characteristic on account of its frequency and its very general distribution in the Cumberland, lower and upper Tennessee, but absolutely missing outside the region. Yet there are two related, but perfectly distinct species, one in southern Alabama and West Florida (*F. succissa* (*Lea*), see: Ortmann, '23, p. 73), the other in the Ozark region (*F. ozarkensis* (*Call*), see Ortmann, Naut. 31. '17 p. 62). The latter tends to demonstrate the former connection of the Ozarks with the Cumberland Plateau. From the headwaters of the Alabama system, the *barnesiana*-group is not yet known.

(*) 9. *Fusconaia barnesiana tumescens* (*Lea*).—MS (!!)

Call was the first to report this form from the Tennessee River in North Alabama, and Hinkley has it from the Mussel-Shoals. I found a number of specimens myself, several of them living, and there is a great material at hand collected by Smith.

Not known from any other place in the lower Tennessee region; but it is present in the larger rivers of the upper Tennessee drainage (Ortmann, '20 p. 288). From the Cumberland it has been reported under the synonym: *Pleurobema crudum* (*Lea*) (see: Wilson & Clark). From Duck River this large-river form is not known, although the other two

forms of the group are abundant. Thus it is a Cumberlandian type.

(*) 10. *Fusconaia barnesiana bigbyensis* (*Lea*).—Headwaters of Duck R. (!!)—Bear Cr., Burleson (Walker coll.)—Spring Cr., Tuscumbia (Walker coll.)—Shoals Cr., Bailey Springs (!!)—Elk R., Estill Springs (!)—Richland Cr., Wales (!!)—Paint Rock R., Princeton (!).

The type locality is in Big Bigby Creek of the Duck River drainage. As the small-creek-form of this group it is absent in the main river, but present, toward the headwaters, in several of the tributaries, and probably more generally distributed than the above records indicate. At several places it has been found to intergrade with the typical *barnesiana*. In a large set collected by Smith in Shoals Creek, without exact locality, all three forms of *barnesiana* are represented. In Elk R., Richland Cr., and Paint Rock R., this form also attains the large size known from elsewhere.

Also Cumberlandian, and apparently abundant in small streams of both, the lower and upper Tennessee drainage, but not yet known from the Cumberland system, where the other two forms seem to be present.

11. *Megalonaias gigantea* (*Barnes*).—Dixie (!!)—MS (!!)—Lower Duck R. (!!).

At Dixie, this species is very abundant, judging from the numbers found in the piles of the clam-diggers. At the other places it is scarce. It has been reported from the Mussel-Shoals by Hinkley. It is absent in the upper Tennessee.

A species of the Interior Basin, advancing into the Cumberland (up to Wayne Co., Ky.) and into the lower Tennessee and Duck rivers.

12. *Amblema costata Rafinesque*.—Dixie (!!)—MS (!!) Duck R., common (!!)—Bear Cr., Burleson (!)—Elk R., Fayetteville (!)—Richland Cr., Wales (!!)—Flint Cr., Flint (!!)—Flint R., Gurley (!)—Hurricane Cr., Gurley (!)—Paint Rock R., Trenton (!)—Princeton (!)—Larkins Fk., Princeton (!)—Sequatchie R., Jasper (!)—Dunlap (!).

Abundant in our region, in larger and smaller rivers, but decidedly rare at Dixie: very few specimens were seen

at this place in the piles of the clam-diggers, mixed in with the abundant *Megalonaias gigantea*.

I call all specimens at hand by this name, although, according to the definition given by Ball ('22 p. 104), some of my material would fall under *A. peruviana* (*Lam.*). Ball gives for the typical *costata* the maximum obesity of 47 per cent of length. Specimens from the upper Duck, Bear Cr., Elk R., upper Paint Rock R., and Sequatchie R. are entirely normal. In the lower Duck and at the Mussel Shoals, they incline to be slightly more swollen, indicating thus the influence of the large-river conditions. Yet, as already Ball (p. 106) has mentioned, shells of his *peruviana*-type (according to obesity) are found in Flint River and Hurricane Creek, and also in Paint Rock River. I have subsequently discovered a similar type in Flint Creek. In the latter case, the "smooth" bottom (sand and mud) seems to be the determining factor. But none of these shells with the obesity of Ball's *peruviana* has the swollen, inflated beaks of the true *peruviana*, and thus I prefer to call all my shells by the name of *costata*: it would be rather unnatural, to separate these individuals with a diameter of over 47 per cent as a different form, since they stand very close to the others, and are generally found associated with them. A higher percentage of diameter should better be made the separating line between the two forms, a percentage where the beaks are usually more prominent.

The single specimen at hand from Dixie is a typical *costata*, with the rather low diameter of 40 per cent.

This form is of wide distribution, in the Interior Basin as well as in Cumberland, lower and upper Tennessee. It is impossible to say where it has its center of origin.

13. *Quadrula pustulosa* (*Lea*).—Dixie (!!)—MS (!!)—Bridgeport (Walker coll.)—Lower and middle Duck R. (!!)—Bear Cr., Burleson (!)—Shoals Cr. (!)—Paint Rock R., Paint Rock (!).

In the main river rather common; also in the lower parts of some of the tributaries. At Burleson, however, it is rather far up, in Bear Creek; in Shoals Creek probably in the lower part only.

This agrees with what is known elsewhere concerning the ecological preferences of this species. It is of wide distribution, being found in the interior Basin, in Cumberland, lower and upper Tennessee. We cannot tell anything about its center of origin.

14. *Quadrula quadrula* (*Rafinesque*).—Lower Duck R., Centreville (!!)—Flint Cr., Flint (!!).

The typical form of this species has been found only at two localities in the Tennessee drainage. It differs from the next form (*fragosa*) in the somewhat more elongated outline, in the greater compression, and in color, which is lighter with green markings, at least in the young shell. It differs also in the weaker development of the sculpture, although this character is not reliable. The best character seems to be obesity, and generally typical *quadrula* has a diameter of the shell of less than 50 per cent of the length. However, since the measurements of an authentic specimen of Rafinesque's *quadrula*, given by Vanatta, show the diameter of 52 per cent, I have decided to select this figure as the upper limit of this form.

Taking the species in this sense, all specimens at hand from the above localities belong here, with the dia. of 47-51 per cent at Centreville (4 specimens), and of 45-51 per cent at Flint (5 specimens). In both cases, the shells were found in mud, and possess the characteristic color of this form, except the largest from Flint, which is brownish. The shape is characterized by the proportional height of the shell (to length), and is 79-83 per cent in Duck R., and 81-85 per cent at Flint, partly overlapping with *fragosa*, which goes in the Tennesee drainage from 83-92 per cent. The tubercles are very variable, but generally less strongly developed than in *fragosa*. Thus the two forms closely inosculate, and should be regarded as varieties of the same species.

Qu. quadrula is abundant in the interior Basin, chiefly in the larger rivers, and seems to prefer more or less muddy bottom and quiet water. It has not been reported from Cumberland River, although *fragosa* is known from it. In the Tennessee, it apparently enters the lower part, goes into the lower Duck, and even beyond the Mussel-Shoals, but ap-

pears in its true form only under favorable conditions, such as are present in the lower part of Flint Creek. In other parts it is represented by the next form. It is absolutely missing in the Tennessee above the Gorge, and thus an immigrant from downstream.

15. *Quadrula quadrula fragosa* (*Conrad*).—Dixie (!!)—MS (!)—Middle Duck R. (!!).

Specimens from Duck River (Columbia, Lillards Mill, Wilhoite; Ortmann, '24 p. 16) and from Dixie are rather typical, with the H. 89-92 per cent of length, and the Dia. 54-62 per cent in Duck, and H. 93-98 per cent and Dia. 53-58 per cent at Dixie. They all have the epidermis of brown color, and the tubercles are generally strongly developed. Specimens from the Mussel-Shoals (4 specimens collected by Smith) have the H. 84-90 per cent, the Dia. 53-58 per cent, and thus are *fragosa*. But in color and development of tubercles they are more like typical *Q. quadrula*, possessing greenish markings (most distinctly the younger ones). The tubercles are not very strongly developed.

This form seems to be closely associated in its distribution with the typical *quadrula*, and is also missing in the Upper Tennessee, but present in the Cumberland. The conditions under which it turns up are not very clear yet. According to my experience (in Duck R.), it prefers gravel bars, while the typical *quadrula* is a mud-lover. From the Tennessee at Dixie I obtained them from clam-diggers' piles, and they probably came, with the rest of the shells, from the gravelly bottom of the main channel. But if this is the case, this form would be remarkable for the fact, that gravel-bottom develops a more swollen, strongly sculptured form, while mud-bottom has a less swollen and less sculptured form. This is—according to the present state of our knowledge—just the opposite of what we see in certain other species. This matter, however, requires further elucidation.

16. *Quadrula verrucosa* (*Rafinesque.*)—Dixie (!!)—MS (!!)—Decatur (Hinkley)—Bridgeport (Walker coll.)—Duck R., common (!!)—Bear Cr., Burleson (!)—Shoals Cr., Bailey Springs (!!)—Elk R., Fayetteville (!)—Richland Cr., Wales (!!)—Flint Cr., Flint (!!)—Hurricane Cr., Gurley

(!)—Paint Rock R., Trenton (!)—Princeton (!)—Sequatchie R., Dunlap (Walker coll.)

Abundant in the whole lower Tennessee drainage, in the main river as well as in most tributaries. Also abundant in the Cumberland and the whole Interior Basin, extending well southward and westward. In the Upper Tennessee it is only in Hiwassee River, but positively missing in the rest of this vast region (Ortmann, '18 p. 540). Thus evidently not a Cumberlandian type, but an immigrant from the Interior Basin, both in the lower Tennessee and the Cumberland. In the Cumberland it goes way up in the headwaters of the South Fork: I found it (Aug. 30, '24) in New River, at New River, Scott Co., Tenn.

17. *Quadrula metanevra* (*Rafinesque.*)—Dixie (!!)—MS (!!)—Limestone Cr., Mooresville (Walker coll.)—Paint Rock R., Paint Rock (!).

Fairly abundant in the Tennessee proper, and also found in the lower parts of Limestone Cr. and Paint Rock R.; absent in Duck R. and the other tributaries. It goes in the upper Tennessee as far as Knoxville, but is rare there (Ortmann, '18, p. 541). It is present, but rare in the Cumberland (Wilson & Clark, '14 p. 59).

Widely distributed in the Interior drainage, extending southward to the Gulf Coastal Plain. Probably not indigenous in the Cumberland region, but an immigrant from the Ohio.

(*) 18. *Quadrula intermedia* (*Conrad*). — MS (Call) (Hinkley) — Bridgeport (Walker coll.)—Duck R., Columbia (!!).

These three localities are the only ones known for the lower Tennessee. The typical *intermedia* is found in Duck R., while what I have seen from Bridgeport is rather the form called *tuberosa Lea*, which probably is only a more swollen form of *intermedia* (Ortmann, '18 p. 541). This same form (*tuberosa*) is also given for the upper Cumberland (Wilson & Clark, '14 p. 59). In the upper Tennessee it is chiefly in the smaller streams, and in its typical form.

A Cumberlandian type, entirely missing in the Interior Basin.

19. *Quadrula cylindrica* (*Say*).—MS (!!) — Bridgeport (Walker coll.)—Duck R. (!!)—Bear Cr., Burleson (!)—Paint Rock R., Paint Rock (!)—Trenton (!)—Princeton (!)—Sequatchie R., Dunlap (Walker coll.)

In the main river and some of its larger tributaries, but not yet known from Elk and Flint Rivers. Widely distributed in the Interior Basin, in Cumberland and upper Tennessee. Thus we cannot locate its center of origin.

20. *Cyclonaias tuberculata* (*Rafinesque*). — MS (!!) — Bridgeport (Walker coll.)—Duck R. (!!)—Shoals Cr. (!)—Richland Cr., Wales (!!)—Flint R., Gurley (!)—Paint Rock R., Paint Rock (!)—Sequatchie R., Dunlap (Walker coll.)

Ball ('22 p. 109) has fixed the diameter of 57 per cent as the upper limit of obesity in this form, and specimens from the above localities thus fall under it. Yet at the Mussel Shoals also the variety is represented (see next form.)

A common form in the Interior Basin, in the Cumberland, lower and upper Tennessee, represented in large rivers by *C. tuberculata granifera*. Its center of origin is obscure.

21. *Cyclonaias tuberculata granifera* (*Lea*).—Dixie (!!) MS (Hinkley) (!).

Specimens with the dia. over 57 per cent are found at Dixie and at the Mussel Shoals. At the latter place the two forms are associated and pass into each other: of 21 specimens at hand, 7 belong to the *granifera*-type (dia. 58-63 per cent), but several of the others come very close to it (dia. ranging from 45-57 per cent). Thus also in the Tennessee the rule holds good, that *granifera* is the more swollen form found in the lower parts of the rivers. The region of transition of the two forms is just at the Mussel Shoals. From Dixie I have only two specimens, with the dia. of 58 and 60 per cent.

As to the general distribution, the same is true as in *tuberculata*, but of course, being absent in the upper parts of all streams, this form is not found in the Tennessee above the Mussel Shoals.

22. *Plethobasus cooperianus* (*Lea*).—Dixie (!!)—Bridgeport (Walker coll.)—Limestone Cr., Mooresville (Walker coll.)

Apparently rare in the lower Tennessee, and not reported from the Mussel Shoals, but it should be remembered that this species is easily confounded with *Quadrula pustulosa*. It goes into the upper Tennessee up to the Knoxville region, but it is rare there (Ortmann, '18 p. 543). It is not rare in the Cumberland (Wilson & Clark, '14 p. 60), and in the Ohio, and probably is an Ohio-type, which immigrated into the Cumberland and Tennessee, remaining restricted to the larger rivers.

23. *Plethobasus cyphyus* (*Rafinesque*).—Dixie (!!)—MS (!!).

In the lower Tennesee drainage sparingly in the main river, but not in the tributaries; also in the Cumberland only in the main river (Wilson & Clark, '14 p. 57). In the upper Tennessee it goes into some of the tributaries, ascending, in the Clinch, into Virginia (Ortmann, '18 p. 544.) It is in the Interior Basin, chiefly in the Ohio River, which might be its center of radiation: but this is not positively assured.

(*) 24. *Lexingtonia dolabelloides* (*Lea*).—MS (!!) — Bridgeport (Walker coll.)—Middle Duck R. (!!)—Limestone Cr., Mooresville (Walker coll.)—Flint R., Gurley (!)—Paint Rock R., New Hope (!)—Paint Rock (!).

The Mussel Shoals are the type locality for several of the synonyms of this form (*thorntoni Lea, mooresianus Lea, subglobatus Lea, circumactus Lea*). The Carn. Mus. has a set from this locality, collected by Smith, and a single specimen (*F.*) collected by myself. It is abundant in middle Duck R. (associated with and passing into *conradi* in the upstream direction; see: Ortmann, '24 p. 18), and is present in the lower parts of Limestone Cr., Flint R., and Paint Rock R. In the upper Tennessee it goes into the lower parts of the larger tributaries (Ortmann, '18 p. 545). The synonym *subglobatus* has been reported by Lea also from Cumberland River at Nashville, but its presence in this system has never been confirmed, and it seems to be absent. It is a large-river-form, passing toward the headwaters into the next form, and a Cumberlandian type, found positively only in the Tennessee drainage from the Mussel Shoals upward.

(*) 25. *Levingtonia dolabelloides conradi* (*Vanatta*).—Middle and upper Duck R. (!!)—Lower Elk R. (Conrad)—Flint Cr. (Conrad)—Flint R., Gurley (!)—Maysville (!)—Paint Rock R., New Hope (!)—Paint Rock (!)—Princeton (!).

This form gradually takes the place of *dolabelloides* in the upstream direction (see: Ortmann, '20 p. 294-296), and it is found in tributaries of the lower as well as the upper Tennessee (Ortmann, '18 p. 546). The type localities of Conrad's *maculatus* (for which *conradi* was introduced) are in "Elk and Flint Rivers" (the latter meaning Flint Creek.) A Cumberlandian type, restricted to the Tennessee drainage.

26. *Pleurobema cordatum* (*Rafinesque*).—Dixie (!!)—MS (!!)—Decatur (Hinkley)—Bridgeport (Walker coll.)—Duck R. (!!)—Paint Rock R., Paint Rock (!).

Rather abundant in the main river, rare in Duck and Paint Rock Rivers, generally favoring larger rivers, as is also the case in the rest of its range: upper Tennessee, Cumberland, and Interior Basin, possibly with its center in the latter, but we cannot be sure about this.

27. *Pleurobena cordatum plenum* (*Lea*).—Dixie (!!)—MS (!!)—Decatur (Hinkley)—Bridgeport (!).

Merely a variation of the typical *cordatum*, and always associated with it all over its range, but generally rare. My specimens from the lower Tennessee are the best representations I have ever seen of this form.

28. *Pleurobema cordatum catillus* (*Conrad*).—MS (!)—Bridgeport (!)—Duck R. (!!)

Accompanying the typical *cordatum* in the main river, but rare; more abundant in Duck River. It has the same relation to the main form in the upper Tennessee (Ortmann, '18 p. 548), and in the Cumberland (see: *solida*, Wilson & Clark, '14 p. 61: "occasional"; I have found it at Burnside, Pulaski Co., Ky.) It is much more abundant in the Ohio and its larger tributaries, and West of the Mississippi it exists without *cordatum*. This again indicates, that the center of the *cordatum*-group might be in the Interior Basin.

29. *Pleurobema cordatum pyramidatum* (*Lea*). — MS

(Hinkley)—Decatur (Hinkley)—Bridgeport (Walker coll.) —Duck R. (!!).

The same holds good in the lower Tennessee as for *catillus*. It even seems to be less frequent in the main river, but in Duck it is more numerous, and also in the upper Tennessee, where it goes a little farther up than the other *cordatum*-forms. In the Cumberland it is also rare (Wilson & Clark, '14 p. 62): I obtained it at Burnside. Like the other forms of the group, it is abundant in the Ohio-drainage, and exists also West of the Mississippi.

30. *Pleurobema clava* (*Lamarck*).—MS (!)—Sequatchie R., Jasper (Walker coll.).

The Carn. Mus. possesses four specimens from Tuscumbia, Ala. (Mussel Shoals) from the *old* Smith collection, which are typical *clava*, and I have seen this species in the Walker collection from Jasper. For the rest, it is unknown from the lower as well as the upper Tennessee*), and represented there by forms of the *oviforme*-group. The specimens reported by Wilson & Clark ('14 p. 57) from tributaries of the upper Cumberland drainage (South Fork and Rockcastle R.) may have been misidentified, and may belong to *oviforme*, which positively exists in West Fork Stones River, Murfreesboro, Rutherford Co., Tenn., where I collected myself a fine set of it. Two specimens of typical *clava* in Carn. Mus. (from the Juny collection), labelled "Cumberland R., Tenn.," have no exact locality, and are thus not convincing. Thus the presence of *clava* in the Cumberland remains doubtful. It is known as a common form in the smaller streams of the Ohio drainage, and its presence in the lower Tennessee indicates, that it has reached these parts coming from the Ohio.

(*) 31. *Pleurobema oviforme* (*Conrad*). — Middle and upper Duck R. (!!)—Bear Cr., Burleson (Walker coll.)—Elk R., Fayetteville (Walker coll.)—Estill Springs (!)—Boiling Fk., Cowan (!)—Flint R., Gurley (!)—Paint Rock R., Trenton (!)—Princeton (!).

* A specimen in the Walker collection, labelled "Elk River, Shelbyville," cannot be considered, because Shelbyville is on Duck River.

This form of moderate obesity belongs to streams of medium size, and thus it is absent in the Tennessee proper, but found in the more important tributaries. In the Tennessee at the Mussel Shoals it is represented by the more swollen *holstonense*, and in the headwaters it passes into the compressed *argenteum*. Similar conditions prevail in the upper Tennessee (Ortmann, '18 pp. 551-554, also: '20 pp. 299, 300).

This is a Cumberlandian type, found also in the upper Cumberland drainage, at least in West Fork Stones River (see above under *clava*). In the Interior Basin it is missing, but represented by *P. clava*, and it may be, that the two are only varieties of one species. However, in the Cumberland region I do not know of any intergrades, while in the upper Ohio specimens of *clava* occasionally incline toward *oviforme*.

(*) 32. *Pleurobema oviforme holstonense* (*Lea*).—MS (!!)—Middle Duck R. (!!)—Limestone Cr., Mooresville (Walker coll.)—Paint Rock R., Paint Rock (!).

Being the form of the larger rivers, *holstonense* is found at the Mussel Shoals, in middle Duck R. (below the range of *oviforme*, see: Ortmann, '24 p. 21), and in the lower parts of Limestone Cr. and Paint Rock River. In the upper Tennessee it goes into the lower parts of the larger tributaries. From the Cumberland it is not known, yet it may be present, since typical *oviforme* is in one of its tributaries.

The type-locality of *holstonense* is Holston R., Tenn., *not* Tuscumbia, as given by Simpson ('14 p. 739). But the Mussel Shoals are type-locality for the synonyms: *mundus Lea*, *lawi Lea*, and *bellulus Lea*.

(*) 33. *Pleurobema oviforme argenteum* (*Lea*).—Upper Duck system (!!)—Elk R., Estill Springs (!)—Boiling Fk., Cowan (!)—Hurricane Cr., Gurley (Walker coll.)—Paint Rock R., Princeton (Walker coll.)—Dry Fk., Hollytree (Walker coll.).

This compressed form of the headwaters is found under similar conditions in the lower Tennessee drainage as in the upper, yet it does not seem to be so generally distributed as in the tributaries above the Knoxville region. It is best developed in upper Elk River, where it also attains the large size, often seen in the upper Tennessee. It has not been

reported from the Cumberland drainage, and it should be emphasized that this large and flat type is nowhere found within the range of *P. clava* in the Ohio drainage.

34. *Elliptio crassidens* (*Lamarck*).—Dixie (!!)—MS (!)—Decature (Hinkley).—Bridgeport (Walker coll.)—Lower Duck R., rare—Limestone Cr., Mooresville (Walker coll.)—Paint Rock R., Paint Rock (!)—Sequatchie R., Jasper (!).

A species generally common in the Interior Basin, in Cumberland, lower and upper Tennessee, but mainly restricted to the larger rivers. The center of origin is obscure, but may be in the Interior Basin.

35. *Elliptio dilatatus* (*Rafinesque*).—Dixie (!!)—MS (!!)—Decatur (Hinkley)—Bridgeport (Walker coll.)—Duck R., common (!!)—Shoals Cr. Bailey Springs (!!)—Elk R., Estill Springs (!)—Richland Cr., Wales (!!)—Flint Cr., Flint (!!)—Flint R., Gurley (!)—Hurricane Cr., Gurley (!)—Paint Rock R., Paint Rock (!)—Sequatchie R., Dunlap (!).

Of wide distribution in the Mississippi, Ohio, Cumberland, and Tennessee drainages, going up in the latter to the headwaters. Also abundant in our region. The center of radiation is thus obscure.

36. *Lastena lata* (*Rafinesque*).—MS (!!)—Duck R., Columbia (!!)—Lower Elk R., (Walker coll.).

This species is in the Walker collection also from the Mussel Shoals, and I had the good luck of finding a dead shell at Florence. Known from the Ohio drainage, from the Cumberland (Wilson & Clark, '14 p. 55), and the upper Tennessee (Ortmann, '18 p. 556). It is altogether a rare shell, the center of distribution of which cannot be ascertained.

(*) 37. *Lasmigona* (*Alasminota*) *holstonia* (*Lea*).—Uppermost Duck R. (!!)—Jones Cr., Bridgeport (!)—Battle Cr., (Walker coll.).

This species is characteristic for small streams, and is rather abundant in the headwaters of the upper Tennessee (Ortmann, '18 p. 557). No localities are known from the Cumberland drainage, and this fact is additional evidence against the assumption, that *Alasmodon badium Raf.* might be the species (see: Ortmann, l. c. and Ortmann & Walker,

'22 p. 36). The three localities given above for the lower Tennessee are also in small streams.

This is a Cumberlandian type, restricted, thus far, to the Tennessee drainage, but also found in the headwaters of the Alabama system, see: Ortmann, '23 pp. 83, 129).

38. *Lasmigona* (*Lasmigona*) *costata* (*Rafinesque*).—MS (!)—Duck R., common (!!)—Bear Cr., Burleson (!)—Shoals Cr., Bailey Springs (!!)—Lawrenceburg (!!)—Elk R., Fayetteville (!)—Estill Springs (!)—Flint R., Gurley (!)—Hurricane Cr., Gurley (!)—Paint Rock R., Trenton (!)—Princeton (!)—Sequatchie R., Dunlap (!).

As elsewhere, this species is rare in the large rivers, but more abundant in the tributaries, and probably is of general distribution in our region. It is extremely abundant in the Interior Basin, chiefly in the Ohio drainage, as well as in Cumberland and upper Tennessee. Hence its center of origin is obscure.

39. *Lasmigona* (*Pterosyna*) *complanata* (*Barnes*). — Lower Duck R. (!!).

Only in the lower Duck R., at Centreville, Ben, and Columbia (Ortmann, '24 p. 23,) and never found at any other place in the rest of the Tennessee drainage; but it probably exists in the lower Tennessee from the mouth of Duck R. downward. It is present in the lower Cumberland, and widely distributed in the Interior Basin. Thus it undoubtedly is an immigrant from the lower Ohio.

40. *Anodonta imbecillis Say.*—Paint Rock R., Paint Rock (!)—Princeton (!).

This species has never been reported before from any part of the Tennessee drainage; it is, however, present in the Cumberland drainage: Wilson & Clark ('14)give it from Haynes Lake, Clarksville, Montgomery Co., Tenn., from East Fork Stones R., Walterhill, and from West Fork Stones R., Murfreesboro, Rutherford Co., Tenn. I found it myself at the latter place on August 30, '21.

It has a wide distribution in the Interior Region, the basin of the Great Lakes, and in southern streams running to the Gulf, including the Alabama-system. The scattered localities in the Cumberland and lower Tennessee indicate a

rather modern immigration, but the direction of it is obscure. It is very probable, that this species possesses exceptional means of dispersal.

41. *Anodonta grandis Say.*—Duck R., Shelbyville (!!)—Flint Cr., Flint (!!)—Mountain Fk., New Market (!).

Only found at three isolated localities in the lower Tennessee region, and in the upper Tennessee system in a pond near Knoxville (var. *gigantea Lea*), and in Emory R., Wartburg, Morgan Co., Tenn. (Ortmann, '18 p. 558, '24 p. 23.) Specimens from Shelbyville and Wartburg represent rather typically the creek-form, but the color of the nacre inclines to purplish or salmon tints. Two specimens from New Market, collected by H. E. Wheeler, Aug. '10, are large and thick-shelled, and strongly resemble the var. *gigantea* in size and shape, but have perfectly white nacre. Six specimens from Flint Creek are the typical creek-form in shape, but rather thin-shelled, and have a peculiar deep copper-color in the nacre, whitish toward the margins. The latter come from a small stream with sluggish current and sandy-muddy bottom.

This species is also known from the Cumberland drainage (see: Ortmann, '24 p. 23), but only from a few, scattered localities; for the rest, it has an immense range in the Interior Basin, southern Coastal Plain, and region of the Great Lakes. It forms thus a case parallel to *A. imbecillis*, and is to be regarded as an immigrant in the Cumberlandian region. At any rate, both *imbecillis* and *grandis*, surely had not their centers of origin in this region.

(*) 42. *Alasmidonta* (*Pressodonta*) *minor* (*Lea*).—Upper Duck and upper Buffalo R. (!!)—Elk R., Estill Springs (!)—Boiling Fk., Cowan (!)—Sequatchie R., Pikeville (!).

A species favoring small streams. It seems to be rare in the lower Tennessee system. In the upper Tennessee it is abundant in the headwaters (Ortmann, '18 p. 560). It is also in the headwaters of the Cumberland River (Wilson & Clark, '14 p. 55).

In addition, it is found in the headwaters of the Kentucky drainage (see: Danglade, '22 p. 5) : I have seen specimens collected by Danglade in North Fk., Kentucky R.,

Whitesburg, Letcher Co., Ky., and I collected it myself in Dix R., Hedgeville, Boyle Co., and Hanging Fork, Lytle, Lincoln Co., Ky., (Sept. '24), where it was rather abundant. It also has been reported by Price from the Green River drainage, in Gasper Cr., Warren Co., Ky., but has not been recently found in this system.

It is to be regarded as a Cumberlandian type, which has crossed over into the Kentucky drainage in the region, where the latter comes in close contact with that of the Cumberland.

43. *Alasmidonta* (*Decurambis*) *marginata* (*Say*).—Duck R. (!!)—Bear Cr., Burleson (!)—Shoals Cr. (!)—Elk R., Fayetteville (!)—Flint R., Gurley (!)—Paint Rock R. Paint Rock (!)—Trenton (!).

Since also this species has a preference for smaller rivers, it is not astonishing, that it has not been found in the Tennessee proper in our region. It is, with the same restrictions, widely distributed in the Interior Basin, chiefly in the Ohio drainage, in the Cumberland and upper Tennessee. No specific center of origin is indicated.

("*Unio diversus*" Conrad (*Alasmidonta diversa* Simpson, '14 p. 500), a spurious species from Shoals Creek, has never been recognized, and it is even doubtful, whether it is an *Alasmidonta*.)

(*) 44. *Pegias fabula* (*Lea*).—Bluewater Cr. (Walker coll.)—Elk R., Estill Springs (!).

Rare in the lower Tennessee, and only in small streams, exactly as in the rest of its range in the upper Tennessee (Ortmann, '18 p. 562). It has not been found in Duck River, but has been reported from Cumberland and Stones R. (Lea). In recent times it has been found in this drainage, only in Rockcastle River (Wilson & Clark, '14 p. 55.)

It is a characteristic Cumberlandian type, absent from the Interior Basin.

45. *Strophitus rugosus* (*Swainson*).—MS (!)—Duck R. (!!)—Elk R., Estill Springs (!).

It is remarkable that this species, common all over the Interior Basin, and common in the Cumberland and upper Tennessee, seems to be much rarer in the lower Tennessee. Yet it has been found in both, tributaries and the main

river: in the Carn. Mus. are specimens collected by Smith at the Mussel Shoals, and Hinkley gives it from the same place. It is fairly abundant in the Duck R. drainage.

Being of wide distribution, the centre of origin is obscure.

46. *Ptychobranchus fasciolare* (*Rafinesque.*)—Dixie (!!)—MS (!)—Bridgeport (Walker coll.)—Duck R. (!!)—Bear Cr., Burleson (!)—Elk R., Estill Springs (!)—Flint Cr., Flint (!!)—Paint Rock R., Paint Rock (!)—Trenton (!).

Not rare in the lower Tennessee, both in main river and tributaries, also in Cumberland and upper Tennessee drainages and in the Ohio system. This wide distribution would not permit the location of its centre of origin. Yet while this species (and the genus) is missing in the whole Mississippi drainage above Cairo*, it is represented in the Ozark region by another, closely allied species *P. occidentale* (*Conr.*), and in the Alabama drainage by *P. greeni* (*Conr.*). In addition, there is another species of the genus in the Cumberlandian region: *P. subtentum* (*Say*). This makes is probable, that the center of origin of the genus was located in the Cumberland region, when it was still connected with the Ozarks, i. e. before the Mississippi Embayment was formed in the later Cretaceous. The present spceies would then be an immigrant from the Cumberland region into the Ohio. I only indicate here this possibility, reserving further discussion for an other occasion.

Two specimens found by myself in Flint Creek are very peculiar, being extremely compressed and rather thin. I did not recognize them as belonging here, till I had examined the soft parts, which, both being females, had the characteristic structure of *Ptychobranchus*. As has been mentioned, the bottom here was sandy mud, with sluggish current.

(*) 47. *Ptychobranchus subtentum* (*Say*).—MS (Hinkley—Duck R. (!!)—Shoals Cr. (!)—Elk R., Estill Springs (!)—Limestone Cr., Mooresville (Walker coll.)—Flint R., Gurley (!)—Maysville (!).

* Reported only once from Wisconsin R., Wis., without exact locality, by Lapham (Pr. Ac Phil. '60), and probably by mistake, since nobody else has found it in this vast region.

In the Cumberland and upper Tennessee not rare, locally abundant, chiefly toward the headwaters (Wilson & Clark, '14 p. 53 and Ortmann, '18 p. 564). The same holds good, apparently, for the lower Tennessee. It is a Cumberlandian type, absent in the Interior Basin.*

48. *Obliquaria reflexa Rafinesque.*—Dixie (!!)—MS (!!) —Decatur (Hinkley)—Bridgeport (Walker coll.)—Lower Duck R. (!!)—Paint Rock R., Paint Rock (!).

This belongs, in the lower Tennessee, to the main river and the lower parts of some of the tributaries. This is in keeping with its ecological preferences elsewhere, in the Interior region, in the Cumberland and upper Tennessee, where it is generally missing in smaller streams. It has a wide distribution, extending also well over the Gulf Plain. No definite center of origin can be pointed out.

49. *Cyprogenia irrorata* (*Lea*)—MS (!)—Bridgeport (Walker coll.)—Duck R., very rare.

This species is widely distributed in the Ohio, Cumberland, and upper Tennessee drainages, preferring the larger rivers. From this distribution, a centre of origin cannot be pointed out. Yet considering the distribution of the *genus*, it is remarkable, that in the upper Mississippi drainage (above Cairo), this genus is entirely missing (a case parallel to that of *Ptychobranchus*), but that it turns up again in the Ozark region as *C. aberti* (*Conr.*). It has no representative in the Alabama drainage, and in this it differs from *Ptychobranchus*. This distribution has a similar tendency to show, that there was an old connection between the Cumberland Plateau and the Ozarks, and that *Cyprogenia* might have had its center in this region, immigrating subsequently into the Ohio drainage.

(*) 50. *Dromus dromas* (*Lea*).—MS (!) — Decatur (Hinkley)—Bridgeport (Walker coll.)—Lower Elk R. (Conrad).

Present in the Cumberland R. (Wilson & Clark, '14 p. 53) and in the upper Tennessee up to the Knoxville region (Ortmann '18 p. 566). It is the form of the larger rivers,

* Call mentions this species from Green and Salt Rivers, Ky., but this is extremely doubtful.

which is also shown in the lower Tennessee. A characteristic Cumberlandian type, not found outside of this region.

(*) 51. *Dromus dromas caperatus* (*Lea*).—Limestone Cr., Mooresville (Walker coll.).

This is the form of smaller rivers, both in the Cumberland and upper Tennessee drainages (Wilson & Clark, l. c. and Ortmann, l. c.) But, since it decidedly avoids the smallest streams of the headwaters, it is understood why it is rare in the lower Tennessee drainage. It is also typically Cumberlandian.

52. *Obovaria* (*Obovaria*) *retusa* (*Lamarck*).—Dixie (!!) —MS (Hinkley) (Walker coll.)—Decatur (Hinkley)—Bridgeport (Walker coll.)—Lower Duck R., rare.

A species of large rivers, most abundant in the Ohio drainage, but also in the Cumberland (Wilson & Clark, '14 p. 52). In the upper Tennessee it goes to the Knoxville region, but is very rare (Ortmann, '18 p. 567). This would indicate, that originally this species belongs to the Ohio, and is an immigrant in the Cumberland as well as the Tennessee.

53. *Obovaria* (*Obovaria*) *subrotunda* (*Rafinesque.*) — Middle Duck R. (!!).

It is very remarkable, that this form of larger rivers has not been found in the lower Tennessee, except in Duck River, although the small-stream-form (*O. surotunda lens*) is rather abundant in this region. Probably it has been accidentally overlooked. This species also belongs to the Ohio and Cumberland drainage. Although Wilson & Clark ('14 p. 52, under *circulus*) do not separate this form from *lens*, I have found typical *subrotunda* in the Cumberland at Burnside, Pulaski Co., Ky., (Sept. 1, '24). *O. subrotunda* is very rare in the Knoxville region (Ortmann, '18 p. 567), and this would suggest an immigration from the Ohio system.

54. *Obovaria* (*Obovaria*) *subrotunda lens* (*Lea*).—Middle and upper Duck R. (!!)—Bear Cr., Burleson (!)—Elk R., Estill Springs (!)—Richland Cr., Wales (!!)—Flint Cr., Flint (!!)—Limestone Cr., Mooresville (Walker coll.) — Flint R., Maysville (!)— Hurricane Cr., Gurley (!)—Paint

Rock R., Paint Rock (!)—Hollytree (!)—Princeton (!) — Sequatchie R., Jasper (!)—Dunlap (Walker coll.).

Abundant in the tributaries of the lower Tennessee; also present in the upper Tennessee, but very rare (Ortmann, '18 p. 568). It has not been mentioned from the Cumberland by Wilson & Clark, but is probably present in the tributaries (see: Ortmann, '24 p. 26), and some of the records given by Wilson & Clark for *"circulus"* surely belong to this form. With the main species, this form probably is an immigrant from the Ohio system.

55. *Obovaria* (*Pseudoön*) *olivaria* (*Rafinesque*).—Dixie (!!)—MS (!!).

Reported from the Mussel Shoals by Hinkley, collected there by Smith and myself, and apparently rare; yet abundant at Dixie. Unknown from the rest of the lower as well as the upper Tennessee region. It is not rare in the Cumberland (Wilson & Clark, '14 p. 52), and widely distributed in larger rivers in the Interior Basin: this indicates, that its center of origin in the latter parts.

56. *Actionaias carinata* (*Barnes*).—Duck R., Ben and Columbia (!!).

I have pointed out ('24 p. 27), that the Duck R. form is the typical *carinata*, not the var *gibba*. When I studied the vast material collected by Smith at the Mussel Shoals, I was astonished, that no specimens belonging here were among it. I suspected that possibly the most common shell at this place had been neglected, just because of its frequency. But when I collected myself at Florence, I did not see a single specimen, although I was looking for this form. Thus the absence (or scarcity) of *A. carinata* at this place is real. Further, I was unable to discover any shells of this type in the piles of the clam-diggers at Dixie, which is significant, since this is one of the best commercial shells. Indeed, the "muckett" was known to the clam-diggers, but considered as extremely rare and precious. Also in Duck R., where I found it, it was comparatively rare.

I have no material before me, which enables me to say, what form of *carinata* is in the Tennessee in northern Alabama. When I inspected specimens in the Walker collection,

I recorded them as *gibba*, and Call ('85 p. 35) expressly states, that the form of the Mussel Shoals and in the Holston is a "peculiar dwarfed" one, which would indicate *gibba*.

This much is sure, that typical *carinata* is in Duck R., and since this species is extremely abundant in the Ohio drainage and other parts of the Interior Basin, we are to look for its center in these parts.

57. *Actinonaias carinata gibba* (*Simpson*).—MS (Call)—Bridgeport (Walker coll.).

If present at all in this part of the Tennessee (see above under *carinata*), this form surely is rare. This is in sharp contrast to its abundance in the Cumberland and the upper Tennessee.

I regard this now as the Cumberlandian representative of *A. carinata* of the Interior Basin: the latter, however, has also advanced into the lower Tennessee and Duck River. Yet further investigations should be made, in order to settle both the taxonomic and geographical relations of these two forms.

(*) 58. *Actionaias pectorosa* (*Conrad*).—MS (Hinkley)—Duck R. (!!)—Bear Cr., Burleson (!)—Lower Elk R. (Conrad)—Elk R., Fayetteville (!)—Estill Springs (!)—Flint R., Gurley (!)—Sequatchie R., Dunlap (Walker coll.)

The lower Elk R. is the type-locality for this species. It is not rare in the lower Tennessee region, chiefly in the tributaries. It is known from the Cumberland system (Wilson & Clark, '14 p. 49), and also from the upper Tennessee (Ortmann, '18 p. 569).

A Cumberlandian type, missing outside of this region.

59. *Truncilla truncata Rafinesque.*—MS (!)—Duck R., rare (!!)—Bear Cr., Burleson (!)—Flint Cr., Flint (!!)—Paint Rock R., Paint Rock (!).

Locally abundant in the lower Tennessee (Mussel Shoals and Paint Rock), in larger and smaller rivers. Widely distributed in the Interior Basin, region of the Great Lakes, and Gulf drainage. Also present in the Cumberland and upper Tennessee, but rare. The center of origin plainly is not in the Cumberland region, but its exact location cannot be given.

60. *Truncilla donaciformis* (*Lea*).—MS (!) — Lower Duck R., rare (!!)—Flint Cr., Flint (!!)—Paint Rock R., Paint Rock (!).

Found frequently associated with the preceding species, but is generally somewhat less abundant. The distribution apparently has been along the same lines, but it should be noted, that *donaciformis* is missing in the upper Tennessee, where *truncata* is found.

61. *Plagiola lineolata* (*Rafinesque*).—Dixie (!!)—MS (!!)—Decatur (Hinkley)—Bridgeport (Walker coll.)—Duck R., rare.—Limestone Cr., Mooresville (Walker coll.)—Paint Rock R., Paint Rock (!).

In the main river, and occasionally in the lower parts of some of the tributaries. Abundant in the Cumberland (Wilson & Clark, '14 p. 52), but rare in the upper Tennessee (Ortmann, '18 p. 571.) It generally prefers larger rivers, and is widely distributed in the Interior Region, extending considerably southward over the Gulf Plain. According to the general character of the distribution, and the scarcity in the upper Tennessee, it probably is *not* a Cumberlandian type, but immigrated from the Ohio.

62. *Leptodea leptodon* (*Rafinesque.*).—MS (!) — Duck R., rare.

Reported by Hinkley from the Mussel-Shoals, and one specimen in the Carn. Mus., collected by Smith. Reported from Duck R. by Hinkley & Marsh (see: Ortmann, '24 p. 28). Rare in the Cumberland and upper Tennessee (Wilson & Clark, '14 p. 51; Ortmann, '18 p. 571). Widely distributed in the Interior Basin with an extension of the range southward, but apparently always a rare shell. No distinct center of origin is indicated.

63. *Leptodea fragilis* (*Rafinesque*).—MS (!!)—Duck R. (!!)—Spring Cr., Tuscumbia (Call)—Shoals Cr. (!)—Flint, Cr., Flint (!!)—Paint Rock Cr., Paint Rock (!)—Sequatchie R., Jasper (!).

Of very wide distribution, from the Gulf Coastal Plain, all over the Interior Basin to the Great Lakes, including Cumberland, lower and upper Tennessee. It prefers larger

rivers with muddy bottom, but is also found in gravel. Center of origin thus obscure.

64. *Proptera alata* (*Say*).—Dixie (!!)—MS (!!)—Decatur (Hinkley)—Duck R. (!!)—Flint Cr., Flint (!!) —Limestone Cr., Mooresville (Walker coll.)—Paint Rock R., Paint Rock (!)—Sequatchie R., Jasper (!)—Dunlap (Walker coll.).

Very similar to the preceding species in its distribution, with the exception, that it is represented in the South by a somewhat different form, *P. purpurata* (*Lam.*). The center of origin is not clear.

65. *Proptera laevissima* (*Lea*).—Flint Cr., Flint (!!).

This species has never before been reported from any place in the Tennessee drainage. It is rare in the lower Cumberland (Wilson & Clark, '14 p. 51.)

For the rest, it is known from the Interior Basin, chiefly in larger rivers, and it is evident, that it has entered Cumberland and Tennessee Rivers coming from the lower Ohio. We are to expect that it will be found, when looked for, in the lowermost Tennessee.

The specimen found by myself in sandy-muddy bottom of Flint Creek is a male, less than half-grown, but characteristic in every respect.

(*Carunculina parva* (*Barnes*).—This species has been reported by Call ('85 p. 41) from Tuscumbia, Ala. It has never been found again at this place, nor elsewhere in our region: thus this record probably is a mistake. The species is missing in the upper Tennessee, but exists in certain tributaries of the Cumberland.)

(*) 66. *Carunculina moesta* (*Lea*).—Duck R. (!!) —Bear Cr., Burleson (!)—Cypress Cr., Florence (!!)—Shoals Cr., Bailey Springs (!!)—Flint Cr., Flint (!!)—Hurricane Cr., Gurley (!)—Paint Rock R., Paint Rock (!)—Trenton (!)—Hollytree (!)—Princeton (!).

A Cumberlandian type, apparently rather generally found in tributaries of the lower Tennessee, and widely distributed, but local, in smaller streams of the upper Tennessee. (Ortmann, '18 p. 573). Also in small streams in the Cumberland drainage (Wilson & Clark, '14 p. 51, as *glans*): I found it

myself in West Fork Stones R., Murfreesboro, Rutherford Co., Tenn., Aug. 30, '21.

In addition, this species is found in the headwaters of the Alabama drainage, generally called there *corvunculus;* and further, in the Ozark uplift (Ortmann, '21 p. 89 and Naut. '24 p. 100). The latter circumstance again indicates the former connection of the Ozarks with the Cumberland Plateau, before the Mississippi Embayment was in existence. In the Interior Region and southward, along the Mississippi lowlands, this species is represented by the closely allied *C. glans* (*Lea*).

(*) 67. *Carunculina moesta cyclindrella* (*Lea*).—Upper Duck R. and trib. (!!)—Elk R., Estill Springs (!)—Flint R., Gurley (!).

The type locality of this form is Duck River. I found it there myself, and in Buffalo River (Ortmann, '24 p. 29). It occurs also in the upper Tennessee region, but only as an occasional variation of *C. moesta,* and associated with the latter*), and for this reason I think it better, to consider it a variety of *moesta.* It has never been found in the Cumberland drainage, nor anywhere else.

(*) 68. *Conradilla caelata* (*Conrad*).—MS (!)—Duck R. (!!)—Lower Elk R. (Conrad)—Flint Cr. (Conrad).

"Tennessee, Elk, and Flint rivers" (the latter is Flint Creek) are the type localities of this species. From the Mussel Shoals it has been reported by Hinkley ('06), and the Carn. Mus. possesses three fine, large specimens collected by Smith. It is a rare shell also in the upper Tennessee region (Ortmann, '18 p. 574). It is not known from the Cumberland, which is an additional argument against making it a synonym of *Lemiox rimosus* (*Raf.*), which is said to be from the Cumberland (see: Ortmann & Walker, '22 p. 56).

It is found nowhere else, and is one of the most interesting shells of the Cumberlandian fauna.

(*) 69. *Medionidus conradicus* (*Lea*).—MS (!)—Duck

* In my paper on the upper Tennessee shells ('18 p. 573) I did not separate this form. I want to state here, that the *cylindrella*-type is represented by some specimens from Little Pigeon R., Sevierville, Sevier Co., Tenn.

R. (!!)—Shoals Cr., Bailey Springs (!!)—Bluewater Cr. (!)—Elk R., Estill Springs (!)—Boiling Fk., Cowan (!)—Flint Cr. (Conrad)—Flint R., Gurley (!)—Paint Rock R., Paint Rock (!)—Trenton (!).

A common species in the Cumberland, upper and lower Tennessee, distinctly preferring small streams and the headwaters. It has not been reported, hitherto, from the main river in Alabama, but the Carn. Mus. possesses a single individual from the Mussel Shoals collected by Smith. This is one of the most characteristic Cumberlandian types, chiefly on account of its abundance. Related forms, belonging to the same genus, are found only in the Alabama drainage, and certain parts of Georgia and Florida: but these are all different species (Ortmann, Naut. '23 p. 58; '24 p. 99).

70. *Micromya fabalis* (*Lea*).—Duck R., (!!).

Compare what I have previously said about the distribution of this species ('24 p. 30 and 40). It is in Duck River and in the upper Tennessee, but not in the Cumberland, nor at any place in the lower Tennessee, outside of Duck R. It is abundant in small streams of the Ohio drainage. Thus it is an exceptional and isolated case, hard to classify.

(*) 71. *Micromya trabalis* (*Conrad*).—MS (!!)—Flint Cr., Flint (!!)—Paint Rock R., Paint Rock (!).

The metropolis of this species seems to be in Cumberland River, in the upper parts. In the lower Tennessee, it apparently is rare. The same is the case in the upper Tennessee, where it has been found in Chicamauga Creek and Hiwassee River, and also (a single individual) in Clinch R., Va. (see Ortmann, '18 p. 576). But an additional specimen has come to hand, from the Sterki collection, which is labelled: Emory River. In the latter river, I have found *M. perpurpurea* (*Lea*), with the nacre only in part of purple color. This form, with purple nacre, represents *trabalis* in Powell, Clinch, and Holston Rivers. There are a few specimens from Holston and Clinch Rivers, where the purple color of the nacre is not so intense, and shades to white, and thus it would be possibly better, to regard *perpurpurea* as a variety of *trabalis*.

A Cumberlandian type, not found outside of the Tennessee and Cumberland drainages.

(*) 72. *Micromya nebulosa* (*Conrad*).—MS (Lea) — Upper Buffalo R. (!!)—Bear Cr., Burleson (!)—Cypress Cr., Florence (!!)—Shoals Cr., Bailey Springs (!!)—Lawrenceburg (!!)—Bluewater Cr. (!)—Lower Elk R. (Call, as: *jonesi*)—Estill Springs (!)—Flint R., Gurley (!)—Maysville (!)—Hurricane Cr., Gurley (!)—Paint Rock R., Paint Rock (!)—Trenton (!)—Princeton (!)—Larkins Fk., Princeton (!)—Crow Cr., Sherwood (!)—Battle Cr., Dove (!)—Little Sequatchie R., Sequatchie (!).

Abundant in smaller streams of the lower Tennessee drainage, but reported also from the Mussel Shoals by Lea (as *U. scitulus* and *planicostatus*). Very abundant under similar conditions in the upper Tennessee region (Ortmann, '18 p. 577), and present also in the Cumberland drainage*).

This should be regarded as a Cumberlandian type, although it is also found in the headwaters of the Alabama drainage. In the Ohio- and Lakes-drainage it is represented by *M. iris* (*Lea*), and this form, chiefly the var. *novi-eboraci* (*Lea*), is very hard to distinguish. It is also to be mentioned that a form resembling *M. iris* is found in the Ozarks (Hinkley, Utterback, and Carn. Mus.)

The taxonomic relations of this species, also to the next species, *M. taeniata*, and the distributional features require further investigation.

(*) 73. *Micromya taeniata* (*Conrad*).—MS (Lea)—Duck and Buffalo R. (!!)—Shoals Cr. (!)—Elk R., Estill Springs (!)—Flint Cr. (Conrad)—Paint Rock R., Paint Rock (!)—Trenton (!)—Princeton (!).

As to the synonymy of this species, and its relation to *M. nebulosa*, compare Ortmann, '24 p. 31. Although I have recently found additional material in the Cumberland drainage, I have not been able to distinguish the three forms admitted by Wilson & Clark ('14 p. 49: *taeniata Conr., picta*

* See: Ortmann, '24 p. 31. To the localities mentioned there (Riverhill, McMinnville, Burnside) should be added: New River, New River, Scott Co., Tenn., coll. Aug. 30, '24.

Lea, and *punctata Lea*); but since I have good material of soft parts, I hope to be able to clear up this question in the future.

As matters stand now, the distribution of this species is in the smaller streams of the Cumberland drainage and of the lower Tennessee; but it is missing in the upper Tennessee. It is found nowhere else, and is thus a Cumberlandian type, peculiarly restricted.

Flint Creek is the type locality of Conrad's *taeniatus;* the Mussel Shoals are type-locality for Lea's *fucatus* and *punctatus*.

(*) 74. *Micromya vanuxemensis* (*Lea*).—MS (!) —Duck R. (!!)—Bear Cr., Burleson (!)—Shoals Cr., Bailey Springs (!!)—Bluewater Cr. (!)—Elk R., Estill Springs (!) —Flint Cr., Flint (!!)—Flint R., Maysville (!)—Hurricane Cr., Gurley (!)—Paint Rock R., Paint Rock (!)—Trenton (!)—Princeton (!)—Jones Cr., Bridgeport (!)—Battle Cr., S. Pittsburg (!)—Sweden Cr., Ketchall (!)—Stream, Jasper (!)—Little Sequatchie R., Sequatchie (!).

As I have pointed out previously ('24 p. 32), the form of this species in the lower Tennessee is not the normal one, but corresponds to that called by Lea *pybasi*, with the shell more elongated*, both in the male and the female, and the postbasal constriction of the true *vanuxemensis* missing. Thus these specimens distinctly approach *M. lienosa* (*Conr.*) of the Alabama system. The essential differences between them have yet to be studied. But specimens of the *pybasi*-type are also found in the upper Tennessee, chiefly in larger streams, and the transition of these into *vanuxemensis* is very gradual and insensible, so that we cannot separate them sharply. On the other hand, here and there in the lower Tennessee, specimens turn up inclining distinctly towards typical *vanuxemensis*, being shorter, and having, in the female, indications of the constriction. The nacre of the lower Tennessee specimens generally is coppery purple, rarely pale to whitish.

A Cumberlandian shell, represented abundantly in the low-

* Often more so than in Lea's figure, but very variable in this respect.

er and upper Tennessee, chiefly in small streams; apparently rare in the Cumberland system. Not found outside of this region, but represented in the upper Alabama drainage by *M. vanuxemensis umbrans* (*Lea*) (Ortmann, Naut. '24 p. 137). Also *M. lienosa* (*Conr.*) of the Gulf drainage might be only a form of this type.

The Mussel Shoals are the type locality of Lea's *pybasi*.

75. *Ligumia recta latissima* (*Rafinesque*).—Dixie (!!)—MS (!)—Bridgeport (Walker coll.)—Duck R., rare.—Limestone Cr., Mooresville (Walker coll.)—Paint Rock R., Paint Rock (!).

Widely distributed in the Interior Basin, in the Cumberland and Tennessee drainages, chiefly in larger rivers, but entering also some smaller ones. No definite center of dispersal can be assigned to this species.

76. *Lampsilis anodontoides* (*Lea*).—Dixie (!!)—MS (Hinkley)—Lower Duck R. (!!).

The typical *anodontoides* belongs to larger rivers with sand and gravel bottom. At Dixie and in the lower Duck I collected it myself. It has a wide distribution in the Interior Basin, extending considerably southward. It exists in the Cumberland (Wilson & Clark, '14 p. 50), but has not been found above the Mussel Shoals in any part of the Tennessee drainage. Thus its center must be located in the Interior Basin, whence it immigrated into the Cumberland and lower Tennessee.

77. *Lampsilis anodontoides fallaciosa* (*Smith*).—MS (!!)—Flint Cr., (!!).

This form is not always sharply separated from the main species: thus I found at Florence a dead shell, resembling in shape *fallaciosa*, but in color rather *anodontoides*. At this place, both rocky-gravelly and muddy bottom exist. The specimens from Flint come from sandy-muddy bottom and sluggish water, and it seems to me, that *fallaciosa* simply is the mud-form of *anodontoides*. Thus its distribution is closely connected (also in the Cumberland) with that of the latter, and apparently subject to the same laws.

(*) 78. *Lampsilis virescens* (*Lea*).—MS (Lea)—Bear Cr., Burleson (!)—Little Bear Cr. (!)—Spring Cr., Tus-

cumbia (Call)—Paint Rock R., Paint Rock (!)—Trenton (!) —Hollytree (!)—Princeton (!).

In addition to the above localities, only the following ones are known: Emory R., Harriman, Roane Co., Tenn. (Ortmann, '18 p. 582); Emory R., Wartburg, Morgan Co., Tenn., (collected by myself, Aug. 16, '23); and Coal Cr., Anderson Co., Tenn. (Walker coll.) Thus this species is restricted to the lower and upper Tennessee drainage, and found only in a very limited portion of the latter. It seems to be most abundant in Paint Rock River, judging from the number of specimens at hand. It is not known from the Cumberland.

Its affinities are, on the one hand, with *L. siliquoidea* (*Barn.*) of the Interior Basin (and elsewhere), on the other, with *L. claibornensis* (*Lea*) of the Alabama drainage.

79. *Lampsilis ovata* (*Say*). — MS (!!) — Bridgeport (Walker coll.)—Duck R. (!!)—Paint Rock R., Paint Rock (!)—Princeton (!).

Preferring the larger rivers, and lower parts of tributaries in the lower Tennessee as well as elsewhere. Abundant, under these conditions, in the upper Tennessee, Cumberland, and Ohio drainages, disappearing in a westerly direction. Thus the center of origin cannot be located.

80. *Lampsilis ovata ventricosa* (*Barnes*).—Dixie (!!)— Duck R. (!!)—Bear Cr., Burleson (!)—Shoals Cr. (!)— Elk R., Fayetteville (!)—Estill Springs (!)—Flint Cr., Flint (!!)—Limestone Cr., Mooresville (Walker coll.)—Hurricane Cr., Gurley (!)—Paint Rock R., Trenton (!)—Sequatchie R., Dunlap (Walker coll.)

This has the same relation to the main species as elsewhere, being often associated with it, but going farther upstream (Ortmann, '18 p. 583). It has the same wide distribution as *L. ovata*, and no definite center of radiation can be recognized.

Some specimens of *L. ovata* from the Mussel Shoals ingrade toward *ventricosa;* the only specimen I collected at Dixie inclines toward typical *ovata*.

81. *Lampsilis fasciola* (*Rafinesque*).—MS (!!)—Bridgeport (Walker coll.)—Duck R. (!!)—Bear Cr., Burleson (!) —Little Bear Cr. (!)—Shoals Cr., Bailey Springs (!!)—

Lawrenceburg (!!)—Bluewater Cr. (!)—Elk R., Estill Springs (!)—Richland Cr., Wales (!!)—Flint R., Gurley (!)—Maysville (!)—Hurricane Cr., Gurley (!)—Paint Rock R., Paint Rock (!)—Trenton (!)—Princeton (!)—Larkins Fk., Princeton (!)—Sequatchie R., Dunlap (Walker coll.)

Of very general distribution in the Ohio drainage, in the Cumberland, lower and upper Tennessee systems, but somewhat scarce in larger rivers, more abundant in smaller ones. No distinct center of origin can be recognized.

82. *Lampsilis orbiculata* (*Hildreth*).—Dixie (!!) — MS (!)—Decatur (Hinkley)—Limestone Cr., Mooresville (Walker coll.)

A species of large rivers, found in the Interior Basin (Mississippi and Ohio), in the Cumberland (Wilson & Clark, '14 p. 49), and in the Tennessee up to the lower Clinch (Knoxville region, Ortmann, '18 p. 585), where it is very rare. The locality in Limestone Creek is remarkable, for generally this species is missing in small creeks. This distribution indicates, that the center of origin is in the Interior Basin.

83. *Dysnomia* (*Truncillopsis*) *triquetra* (*Rafinesque.*) — MS (!)—Bridgeport (Walker coll.)—Duck R. (!!)—Bear Cr., Burleson (!)—Flint R., Maysville (!)—Paint Rock R., Paint Rock (!).

Widely distributed in larger and smaller rivers in the Interior drainage, in the Cumberland, lower and upper Tennessee, but nowhere very abundant. Its center of origin is obscure.

(*Dysnomia* (*Truncillopsis*) *arcaeformis* (*Lea.*)—As to the presence of this species in the "Tennessee in Alabama," see: Ortmann, '18 p. 586: It originally comes from the Cumberland River. It has been procured there by others (Wilson & Clark, '14 p. 46), but is rare. It is more abundant in the Knoxville region of the upper Tennessee. It has never been reported from the lower Tennessee. The Carn. Mus. possesses a set, some specimens of which were labeled: "North Alabama," and I have a note, that it is in the Walker collection from the Mussel Shoals. Yet it seems to me to require additional evidence, before we admit this species as a member of the fauna of the lower Tennessee.)

(*) 84. *Dysnomia* (*Truncillopsis*) *brevidens* (*Lea*).—MS (!)—Duck R. (!!)—Lower Elk R. (Conrad, '38).

Reported from the Mussel Shoals by Hinkley, and present from this place in the Walker collection and in Carn. Mus., collected by Smith. Apparently rare in our section, as is seen by the small number of localities known. Also rare in the Cumberland (Wilson & Clark, '14 p. 45), but more abundant in the upper Tennessee (Ortmann, '18 p. 586).

Found nowhere else, and thus a typical member of the Cumberlandian fauna.

(*) 85. *Dysnomia* (*Truncillopsis*) *lenior* (*Lea*).—Duck R., rare.—Paint Rock R., Woodville (Simpson)—Paint Rock (!)—Trenton (!)—Hollytree (!).

A rare Cumberlandian species, found at a few places in the Cumberland, upper and lower Tennessee drainages, in small rivers (Ortmann, '18 p. 587; '24 p. 34). In Paint Rock River it seems to be most abundant, judging from the material at hand.

(*Dysnomia* (*Truncillopsis*) *metastriata* (*Conrad*).—This has been given by Simpson ('14 p. 10) from Woodville, Alabama. This surely is a mistake, for the species belongs to the Alabama drainage.)

86. *Dysnomia* (*Scalenilla*) *sulcata* (*Lea*).—MS (!!).

Very few exact localities are known for this species. From the Cumberland it has been reported (Wilson & Clark, '14) from Halfpone Bar, Cheatham Co., Tenn.; Goodall Island, Smith Co., Tenn., and also Caney Fork, Buffalo Valley, Putnam Co., Tenn. Other exact localities are: Ohio R., Cincinnati, Hamilton Co., O. (Lea); Wabash R., Lafayette, Tippecanoe Co., Ind. It has been credited to the Ohio R. in Illinois (Baker), and Indiana (Call, Daniels), to the Kentucky River ((Rafinesque), but not found there recently by Danglade ('22). Call reports it from a tributary to the Wabash, White River, and Daniels from West Fork White Riv., Marion Co., Ind. From the Wabash drainage it must have crossed over into the lake drainage, where it exists as a variety: *D. sulcata delicata* (*Simpson*). From the Mussel Shoals it has been reported by Hinkley, the Carn. Mus. possesses it (donated by Walker), and I found it myself.

The distribution clearly centers in Ohio and Wabash Riv-

ers, and it is an immigrant both in Cumberland and Tennessee Rivers.

(*) 87. *Dysnomia* (*Scalenilla*) *haysiana* (*Lea*).—*MS* (Hinkley)—Lower Elk R. (Conrad, '37)—Elk R., Fayetteville (Walker coll.)

Apparently rare and local in the lower Tennessee, but more abundant in Cumberland R. (Wilson & Clark, '14 p. 40) and in the upper Tennessee (Ortmann, '18 p. 587). A Cumberlandian type, not found outside of this region.

88. *Dysnomia* (*Pilea*) *personata* (*Say*).—MS (!!).

Reported by Hinkley from the Mussel Shoals, and found there by myself (2 dead shells, male and female). Only two other exact localities are known: Ohio R., Cincinnati, Hamilton Co., O. (Lea), and Wabash R., New Harmony, Posey Co., Ind. (Daniels). In a general way it is mentioned from the Ohio and the Wabash R., in Indiana (Call.)

It seems to be a species centering in the lower Ohio, and is one of the rarest Naiades.

(*) 89. *Dysnomia* (*Pilea*) *biemarginata* (*Lea*).—MS (!) —Elk R., Fayetteville (Walker coll.)—Paint Rock R., Paint Rock (Walker coll.)

The Mussel Shoals are the type-locality for this species, and it seems to be abundant there. Two additional localities are known in the lower Tennessee drainage, and, in addition, it is in the Cumberland and South Fork at Burnside, Pulaski Co., Ky. (Walker coll.), but not mentioned by Wilson & Clark ('14.)

It is a Cumberlandian type found only in the Cumberland and lower Tennessee, absent in the upper Tennessee, but probably the next form (*turgidula*) represents it in the Knoxville region.

(*) 90. *Dysnomia* (*Pilea*) *turgidula* (*Lea*).—MS (Lea) —Duck R., Shelbyville (!!)—Bear Cr., Burleson (!)—Shoals Cr. (Hinkley).

The Mussel Shoals are one of the type-localities of this species. As to its distribution, compare Ortmann ('18 p. 590 and '24 p. 35). From the Cumberland (which is its other type-locality), it has not been recently reported.

A Cumberlandian type, missing in the Interior Basin, but

turning up again in the Ozarks (as *curtisi Friers. & Utterb.*, see: Ortmann & Walker, '22 p. 69 and Ortmann, '24 p. 35, footnote). This is another case indicating a former connection of the Ozark with the Cumberland Plateau.

(*) 91. *Dysnomia* (*Pilea*) *florentina* (*Lea*)—MS (!)—Cypress Cr., Florence (Walker coll.).

Known from the type-locality at the Mussel Shoals, and from Cypress Creek in close vicinity. It has been reported from the Cumberland River (Wilson & Clark, '14 p. 46), and at least "a very inflated female" from Halfpone Bar, Cheatham Co., Tenn., would seem to belong here. Other specimens, chiefly those reported from the upper Tennessee (Ortmann, '18 p. 591) should rather be placed with the next form (*D. florentina walkeri*, see: Ortmann, '24 p. 35).

A Cumberlandian form, probably peculiar to larger rivers, and represented in smaller streams by the next form, and thus not found in the upper Tennessee.

(*) 92. *Dysnomia* (*Pilea*) *florentina walkeri* (*Wilson & Clark*).—Duck R. (!!)—Limestone Cr., Mooresville (Walker coll.)—Flint R., Gurley (!)—Maysville (!)—Hurricane Cr., Gurley (!).

I have discussed this form, and its relation to *florentina*, in a previous paper ('24 p. 35). It is the form representing the latter in small streams and headwaters, and is found in the upper and lower Tennessee drainage and in tributaries of the Cumberland* but nowhere else, and is a true Cumberlandian type.

(*) 93. *Dysnomia* (*Pilea*) *capsaeformis* (*Lea*).—MS (!)—Duck R. (!!)—Bear Cr., Burleson (!)—Shoals Cr. (!)—Elk R., Fayetteville (!)—Richland Cr., Wales (!!)—Limestone Cr., Mooresville (Walker coll.)—Paint Rock R., Paint Rock (!)—Trenton (!)—Hollytree (!)—Princeton (!).

Apparently as abundant in the lower Tennessee drainage as in the upper, both in larger and smaller streams (Ortmann, '18 p. 593). It is also found in the Cumberland drainage (Wilson & Clark, '14 p. 46.)

---

* On Sept. 1, '24, I found a male *walkeri* in Cumberland R., Burnside, Pulaski Co., Ky.

It does not exist outside of the Cumberland region, and, on account of its frequency, belongs to the most characteristic Cumberlandian types.

94. *Dysnomia* (*Pilea*) *torulosa* (*Rafinesque*).—MS (!) —Decatur (Hinkley).

Only in the main river, and going up as far as Knoxville (Ortmann, '18 p. 589). Reported from the Mussel Shoals by Conrad and Hinkley. It has never been reported from the Cumberland, but is known from the Ohio drainage, and credited to the Ohio in Illinois (Baker) and Indiana (Call) (Daniels), to the Wabash, Green, and Kentucky Rivers (Rafinesque), and even the Scioto River in Ohio (Lea) (Conrad). But I know only of one exact and reliable locality: Wabash R., New Harmony, Posey Co., Ind. (Daniels.)*

Thus, the home of this species seems to be in the lower Ohio, whence it ascended into the Tennessee, following the main river to the Knoxville region. Above the latter, it changes into the headwaters-form *D. torulosa gubernaculum* (*Reeve*) (see: Ortmann, '18 p. 590.)

(*) 95. *Dysnomia* (*Pilea*) *torulosa propinqua* (*Lea*). — MS (!).

The Mussel Shoals are the type-locality of this form. Besides, it is found in the upper Tennessee in larger rivers in the Knoxville region (Ortmann, '18, p. 589). No other records are at hand, except one given by Baker (Bull. Ill. St. Lab. 7, '06 p. 63) from Ohio R., Illinois, without exact locality. Since this has never been verified, I consider it spurious. This makes this a Cumberlandian type, restricted to the lower and upper Tennessee.

Ball ('22 p. 115) considers *propinqua* a separate species, because it does not intergrade with the other two forms discussed by him (*torulosa* and *gubernaculum*), "in so far as obesity is concerned." Yet his figures for the obesity of

* Ohio R., Cincinnati, Hamilton Co., O., for *cincinnatiensis Lea*, is doubtful, because the status of this form is not settled; and Scioto R., Columbus, Franklin Co., O., probably is incorrect, since the species is not found in so small streams.

propinqua vary from 55 to 62 percent, and for *torulosa* from 51-62 per cent, which is almost identity in this respect.*)

D. propinqua is merely a *torulosa* with the tubercles very poorly or not at all developed, and the two forms actually intergrade in this respect. *D. torulosa gubernaculum* of the upper Tennessee resembles *propinqua* in the absence of tubercles, but is distinctly more compressed.

(*Dysnomia* (*Dysnomia*) *stewardsoni* (*Lea*).—A male of this species in the Carn. Mus. from the Hartman collection is said to be from Florence, Ala. Since this species has never been found in this region by others, and since the locality-records in the Hartman collection are to be used cautiously, it is better to drop this species from the list. It is positively known only from the Knoxville region of the upper Tennessee, chiefly from Holston River (Ortmann, '18 p. 588.)

* The apparent absence of integrades in obesity in Ball's table, p. 114, is undoubtedly due to scarcity of material.

DISCUSSION OF THE NAIAD-FAUNA OF THE LOWER TENNESSEE.

The total number of forms (species and varieties) found in our region is 95; of these 39 are Cumberlandian types (marked in the text by (*)), which is 41 per cent.* But not *all* Cumberlandian forms have been found in the lower Tennessee. The following are missing, according to the list given by me previously ('24 pp. 42-44):

1. *Quadrula cylindrica strigillata* (*Wright*)
2. *Plethobasus cyphyus compertus* (*Frierson*)
3. *Alasmidonta* (*Decurambis*) *raveneliana* (*Lea*)
4. *Micromya trabalis perpurpurea* (*Lea*)
5. *Dysnomia* (*Truncillopsis*) *arcaeformis* (*Lea*)
6. *D.* (*Pilea*) *torulosa gubernaculum* (*Reeve*)
7. *D.* (*Dysnomia*) *stewardsoni* (*Lea*)
8. *D.* (*Dysn.*) *lewisi* (*Walker*)

* As additional Cumberlandian types possibly are to be regarded three others (*Cumberlandia monodonta, Ptychobranchus fasciolare,* and *Cyprogenia irrorata*); but I shall disregard these in the following considerations, because they require further study, and because others may fall under the same class.

Five of these (Nos. 1, 2, 3, 4, 6) plainly are merely local forms of the upper Tennessee drainage, possessing representatives in the lower Tennessee, and only three *Dysnomias* (Nos. 5, 7, 8) ar peculiar, well defined types, belonging exclusively to the upper Tennessee, and not at all represented in our region. *D. arcaeformis* and *lewisi* are also known from the Cumberland, while *D. stewardsoni* is very restricted in its range, being known hitherto only from the Knoxville region.

Thus a very large majority of all Cumberlandian shells is found in the lower Tennessee: 39 out of 47 (83 per cent).

On the other hand, we have in the lower Tennessee a number of shells, which immigrated from the lower Ohio (or the Interior Basin in general). According to what has been explained in the text above, this is more or less assured in the following:

1. *Fusconaia ebenus*
2. *Megalonaias gigantea*
3. *Quadrula quadrula*
4. *Quadrula quadrula fragosa*
5. *Quadrula verrucosa*
6. *Quadrula metanevra*
7. *Plethobasus cooperianus*
8. *Pleurobema clava*
9. *Lasmigona complanata*
10. *Anodonta imbecillis*
11. *Anodonta grandis*
12. *Obovaria retusa*
13. *Obovaria subrotunda*
14. *Obovaria subrotunda lens*
15. *Obovaria olivaria*
16. *Actinonaias carinata*
17. *Truncilla truncata*
18. *Truncilla donaciformis*
19. *Plagiola lineolata*
20. *Proptera laevissima*
21. *Lampsillis anodontoides*
22. *Lampsilis anodontoides fallaciosa*
23. *Lampsilis orbiculata*
24. *Dysnomia sulcata*
25. *Dysnomia personata*
26. *Dysnomia torulosa*

These 26 forms make 27 per cent of the fauna. In addition there are 27 others (28 per cent), not mentioned here, in which the center of origin is obscure, they being uniformly present in the Interior Basin and in the Cumberland Region. Some of them will finally prove to belong originally to the Interior Basin, while others may have had their center in the Cumberland Region (if we ever shall be able to find this out.)

This all refers to the *lower Tennessee as a whole.* As

will be seen further below, in the lowermost Tennessee (at Dixie), the Cumberland types are entirely missing.

The above statements lead to the conclusion, *that originally there must have existed a separation of two faunistic types in two different drainage systems, a Cumberlandian River and an Interior Basin River, and that subsequently these two systems became connected, so that their faunas had a chance to mingle.* Of course, the process was not so simple, for the reason, that probably also each one of these two systems had a varied history of its own, during which different parts of their drainages were connected and separated in various ways. This is indicated by the distribution of the different shells, which by no means are uniformly distributed in these old drainage systems.

I should like to emphasize again a fact, indicated already in a previous paper ('24 p. 46). This is, that the *"distribution of the Cumberlandian Naiad fauna is markedly discontinuous"* (at the present time), "being found in the upper Cumberland, the upper Duck, and the Tennessee above the Mussel Shoals, but *not* in the *lower* Cumberland, the *lower* Duck, and probably also the *lower* Tennessee." The latter fact, which was inferred from the conditions observed in the lower Duck River, but not then positively established, has now been *fully demonstrated* by the collections made by myself at Dixie. *Of the 25 forms found here (see below), not a single one belongs to the Cumberlandian types.* The stretch of the Tennessee between the Mussel Shoals and Dixie is unknown, but the lower boundary of the Cumberland fauna must be located in this region.

In order to support this I give here an enumeration of the Naiades which exist at the Mussel Shoals and at Dixie, considering also those which *might* be present.

Fauna of the Mussel Shoals. (*—Cumberlandian; O—Ohioan.)

For the following we possess positive records:

1. *Cumberlandia monodonta*
02. *Fusconaia ebenus*
3. *F. subrotunda*
*4. *F. cuneol. appressa*
*5. *F. edgariana*
*6. *F. barnesiana*
*7. *F. barn. tumescens*
08. *Megalonaias gigantea*

9. *Amblema costata*
10. *Quadrula pustulosa*
011. *Qu. quadrula fragosa*
012. *Qu. verrucosa*
013. *Qu. metanevra*
*14. *Qu. intermedia*
15. *Qu. cylindrica*
16. *Cyclonaias tuberculata*
17. *C. tub. granifera*
18. *Plethobasus cyphyus*
*19. *Lexingtonia dolabelloides*
20. *Pleurobema cordatum*
21. *Pl. cord. plenum*
22. *Pl. cord. catillus*
23. *Pl. cord. pyramidatum*
024. *Pleurobema clava*
*25. *Pleur. ovif. holstonense*
26. *Elliptio crassidens*
27. *E. dilatatus*
28. *Lastena lata*
29. *Lasmigona costata*
30. *Strophitus rugosus*
31. *Ptychobranch. fasciolare*
*32. *Pt. subtentum*
33. *Obliquaria reflexa*
34. *Cyprogenia irrorata*
*35. *Dromus dromas*
036. *Obovaria retusa*
037. *O. olivaria*
*38. *Actinonaias car. gibba*
*39. *Act. pectorosa*
040. *Truncilla truncata*
041. *Tr. donaciformis*
042. *Plagiola lineolata*
43. *Leptodea leptodon*
44. *L. fragilis*
45. *Proptera alata*
*46 *Conradilla caelata*
*47. *Medionidus conradicus*
*48. *Micromya trabalis*
*49. *M. nebulosa*
*50. *M. taeniata*
*51. *M. vanuxemensis*
52. *Ligum. recta latissima*
053. *Lampsilis anodontoides*
054. *L. anod. fallaciosa*
*55. *L. virescens*
58. *L. ovata*
57. *L. fasciola*
058. *L. orbiculata*
59. *Dysnomia triquetra*
*60. *D. brevidens*
061. *D. sulcata*
*62. *D. haysiana*
063. *D. personata*
*64. *D. biemarginata*
*65. *D. turgidula*
*66. *D. florentina*
*67. *D. capsaeformis*
068. *D. torulosa*
*69. *D. tor. propinqua*

According to their general distribution, the following forms should also be expected here, and probably are present.

070. *Quadrula quadrula*
071. *Plethob. cooperianus*
72. *Alasmidonta marginata*
073. *Obovaria subrotunda*
074. *Proptera laevissima*
75. *Lamps. ov. ventricosa*

Thus, in a fauna of 75 forms, 25, or 33 per cent. are Cumberlandian, and 21, or 28 per cent, are Ohioan.

At Dixie, I have collected the following:

1. *Fusconaia ebenus*
2. *F. subrotunda*
3. *Megalonaias gigantea*
4. *Amblema costata*
5. *Quadrula pustulosa*
6. *Qu. quadr. fragosa*
7. *Qu. verrucosa*
8. *Qu. metanevra*

9. *Cycl. tuberc. granifera*
10. *Plethobas. cooperianus*
11. *Pl. cyphyus*
12. *Pleurobema cordatum*
13. *Pl. cord. plenum*
14. *Elliptio crassidens*
15. *E. dilatatus*
16. *Ptychobr. fasciolare*
17. *Obliquaria reflexa*
18. *Obovaria retusa*
19. *O. olivaria*
20. *Plagiola lineolata*
21. *Proptera alata*
22. *Ligum. rect. latissima*
23. *Lampsilis anodontoides*
24. *L. ov. ventricosa*
25. *L. orbiculata*

This, of course, is not the complete fauna; but according to their general distribution, we should expect also the following shells here.

26. *Cumberl. monodonta*
27. *Quadrula quadrula*
28. *Qu. cylindrica*
29. *Pleurob. cord. catillus*
30. *Pl. cord. pyramidatum*
31. *Pl. clava*
32. *Lastena lata*
33. *Lasmigona costata*
34. *L. complanata*
35. *Alasmod. marginata*
36. *Strophitus rugosus*
37. *Cyprogenia irrorata*
38. *Obovaria subrotunda*
39. *Actinonaias carinata*
40. *Truncilla truncata*
41. *T. donaciformis*
42. *Leptodea leptodon*
43. *L. fragilis*
44. *Proptera laevissima*
45. *Lamps. anod. fallaciosa*
46. *Lamps. ovata*
47. *L. fasciola*
48. *Dysnomia triquetra*
49. *D. sulcata*
50. *D. personata*
51. *D. torulosa*

(I purposely left out the two species of *Anodonta* on account of their erratic distribution, and their general absence from large rivers.)

Although this latter list does not seem to be very reliable, and is largely conjectural, two prominent features are indicated: (1) the comparatively poor character of the fauna at Dixie (51 Naiades against 75 at the Mussel Shoals), and (2) *the total absence of Cumberlandian types. Thus the lowermost Tennessee faunistically belongs to the Interior Basin.* This strongly contrasts with the conditions at the Mussel Shoals, where Cumberlandian elements are well represented.

Farther up in the Tennessee, the elements of the Interior Basin gradually disappear, and in the Tennessee drainage above Walden Gorge, the proportion of Cumberlandian and Interior Basin types is as follows (compare: Ortmann, '18).

The total number of Naiades present is 88. Of these 44

(or 50 per cent) are Cumberlandian, while only 12 (or 14 per cent) belong to those which probably immigrated from the lower Ohio. The rest, 36 per cent, are unknown as to origin. This shows a distinct increase of percentage of Cumberlandian forms (against 41 per cent in the lower Tennessee); on the other hand, the Ohio-types have decreased (from 27 per cent to 14 per cent.)

Very interesting is the comparison of the Knoxville region with the Mussel Shoals. These two localities may very well serve as a basis for judging the mutual relations of their faunas, for they represent similar stretches of the river, equally well studied. According to the list given in my paper ('18 pp. 624, 625) for the *Tennessee River in Knox Co.*, 64 Naiades are known from these parts. Of these, 28 (or 44 per cent) are Cumberlandian, 8 (or 13 per cent are Ohioan, and the rest (43 per cent) is of unknown origin, while at the Mussel Shoals these percentages, as we have seen, are: 33 per cent, 28 per cent (and 39 per cent.)

This all serves to support the conclusion that, considering the whole Tennessee drainage, *we have, in the lowermost parts (Dixie), a rather pure Ohio (or Interior Basin) fauna; in the region of the Mussel Shoals (probably somewhat below), Cumberlandian types begin to appear; farther up, the latter become more and more prevalent, and the Ohio types gradually disappear,* but nevertheless they constitute a certain percentage of the fauna at least as far as the Knoxville region. This decrease of Ohio elements continues farther up from Knoxville. *On the other hand, the percentage of the Cumberlandian forms correspondingly increases from the lower to the upper Tennessee,* which, however, is not so much due to an increase of the number of these types, but is largely brought about by the decrease alone of that other element.

We do not need to go into details with regard to the headwaters of the Tennessee: but I should like to mention, that in the lower parts of Holston and Clinch Rivers a few Ohio-types are still present, but they soon disappear. Also the types of unknown origin become gradually fewer in the upstreams direction, while, on the other hand and in conse-

quence of this, the Cumberlandian forms increase in percentage (less so in absolute numbers); at some of the well worked headwaters stations in Holston, Clinch and Powell Rivers, their percentage goes up to 75 per cent and even higher.

It is also not necessary to consider more in detail those forms, which, on account of their wide and general distribution, we have classified as of doubtful origin. Yet attention should be directed to the probability, that just among them we may have Cumberlandian types, which *descended* the Tennessee River (and also the Cumberland), and invaded the Ohio and the Interior Basin. In a few cases, we have evidence to this effect; but in most of them, the details of their distribution *in the Interior Basin* must be studied more closely, before we shall be able to draw any conclusions.

APPENDIX.

Note Concerning Unio cor Conrad.

Frierson's figure of the Type of *U. cor* (Naut. 29. '16 pl. 3 f. 1-3) is either *Fusconaia edgariana* (*Lea*) or *F. cuneolus appressa* (*Lea*), and, as I believe, probably the latter, but this cannot be made out from the figure alone, which does not show color and texture of epidermis. In shape, it absolutely resembles a typical *appressa*, a form which I did find at one of Conrad's type-localities for *cor*, in Flint Creek, (see above p. 329). Pilsbry (in: Ortmann & Walker, '22 p. 7) says that *cor* resembles *appressa* in the epidermis, but that it differs from either, *edgariana* and *appressa*. But the difference given do not hold good: the posterior ridge varies in sharpness, and so does obesity. According to Ortmann ('20 p. 284, 285), the diameter ranges, in *appressa*, from 51 to 66 per cent; Frierson's figure has 68 per cent; and my specimen from Flint: 57 per cent. Thus from the study of the type specimen, *cor* rather seems to be *appressa*.

But this would not have any influence upon nomenclature: the original *cor* is not sufficiently characterized so as to make out, whether it is *edgariana* or *appressa*, and even Frierson's redescription and figure leave the question undecided. Thus Lea's name stands. There is hardly any probability, that there exists, in this region, a *third* form (*cor*), different from either *edgariana* and *appressa*.

BIBLIOGRAPHY.

Ball, G. H.—Variation in Freshwater Mussels (Ecology. 3. 1922 pp. 93-121.)

Boepple, J. F. & Coker, R. E.—Mussel Resources of the Holston and Clinch Rivers of Eastern Tennessee (Bur. Fisher. Doc. No. 765. 1912 pp. 1-13.)

Call, R. E.—Geographical Catalogue of the Unionidae of the Mississippi Valley (Bull. Des Moines Acad. Sci. 1. 1885 pp. 1-57.)

Conrad, T. A.—New Freshwater Shells of the United States. Philadelphia, 1834.

Conrad, T. A.—Monography of the Family Unionidae. Philadelphia, 1836-1838.

Danglade, E.—The Kentucky River and its Mussel Resources (Bur. Fisher. Doc. No. 934, 1922 pp. 1-8.)

Hinkley, A. A.—List of Alabama Shells collected in October and November 1903 (Nautilus 18. 1904 pp. 54-57.)

Hinkley, A. A.—Some Shells of Mississippi and Alabama (Nautilus, 20. 1906 pp. 52-55.)

Lea, I.—Observations on the Genus Unio. Vol 1-13. 1832-1874.

Ortmann, A. E.—The Nayades (Freshwater Mussels) of the Upper Tennessee drainage, with notes on synonymy and distribution (Pr. Amer. Philos. Soc. 57, 1918 pp. 521-626.)

Ortmann, A. E.—Correlation of Shape and Station in Freshwater Mussels (Naiades) (Pr. Amer. Philos. Soc. 59. 1920 pp. 269-312.)

Ortmann, A. E.—The Anatomy of certain Mussels from the upper Tennessee (Nautilus. 34. 1921 pp. 81-91.)

Ortmann, A. E. & Walker, B.—On the Nomenclature of certain North American Naiades (Occas. Pap. Mus. Zool. Univ. Mich. No. 112. 1922 pp. 1-75.)

Ortmann, A. E.—The Anatomy and Taxonomy of certain Unioninae and Anodontinae from the Gulf drainage (Nautilus. 36. 1923 pp. 73-84; 129-132.)

Ortmann, A. E.—Notes on the Anatomy and Taxonomy of certain Lampsilinae from the Gulf drainage (Nautilus. 37. 1923 pp. 56-60; 1924 pp. 99-105; 137-144.)

Ortmann, A. E.—The Naiad fauna of Duck River in Tennessee (Amer. Midl. Natural. 9. 1924 pp. 3-47.)

Simpson, C. T.—A descriptive Catalogue of the Naiades, or Pearly Freshwater Mussels. Detroit, 1914.

Wilson, C. B. & Clark, H. W.—The Mussels of the Cumberland River and its Tributaries (Bur. Fisher. Doc. No. 781. 1914 pp. 1-63.)

THE PRESENT STATUS OF THE RUFFED GROUSE IN PENNSYLVANIA.

BY

GEORGE MIKSCH SUTTON

Chief, Educational Service, Penna. State Game Commission.
Official State Ornithologist of Pennsylvania.

The richly colored woods of autumn would seem strangely silent without a familiar whirr of wings and a glimpse of that magnificent broad-tailed bird so dear to the hearts of every sportsman; and lifeless would seem the mildest days of May, even with the music of vireos, tanagers, and thrushes all about us, were we not occasionally to hear the distant throbbing of grouse wings sounding the summons to new life and Spring. Wherever he is found the Ruffed Grouse is a favorite; not alone to the sportsman, for his cunning ways and the disconcerting uproar of his flight, but to every man who has ever known the woods, for his beauty and character.

Unpleasant as it is to face such a situation, our Pennsylvania Ruffed Grouse (*Bonasa umbellus umbellus*) are in danger of extermination. Letters and verbal reports have come into the Game Commission offices, not only from all parts of the State, but from points throughout the entire range of the bird, indicating in many regions an almost unprecedented scarcity of this game bird. It should be understood that the scarcity of grouse is not alone restricted to Pennsylvania; but the present paper will consider only the local situation. In many regions where even so recently as during the 1923 hunting season dozens or hundreds of birds were seen, our game protectors have found but four or five birds. Some of the more fortunate sportsmen have found larger numbers of birds far back in the wilds, associated

in large flocks, and there is a report abroad that all the birds have merely pushed farther than usual into the ridges, and this is doubtless to an extent and locally true. But any man who has walked for days through typical grouse country where the birds had been known to occur abundantly, without seeing more than four or five birds; any man who has viewed the past season's kill (1924), with its pitiably small proportion of young birds; any man who has heard the direct words of hunters in almost all portions of the State, bewailing a loss of grouse—anyone who has faced these facts personally, as I have, cannot doubt a wide-spread and alarming decrease in the grouse population. The situation is serious in some sections, and the mere fact that certain regions are still favored with the usual supply of birds does not make the general problem less important. The sportsman who thinks that the birds are as abundant as usual because he has seen them far back on the ridges, where he is not accustomed to hunt them, concludes that all the birds have moved back to the wilder areas. He forgets that these wilder areas are usually not investigated at all, and therefore supposes that all birds have moved thence, without taking into consideration the normal grouse population of these very areas.

Naturally, many interested sportsmen and nature-lovers have sought an explanation of this decrease in the grouse population, and as an interested student it is thought wise to give the result of our inquiries into the situation. It is safe to state that the sportsmen themselves have not been responsible to any greater extent than usual for this decrease, although it will be admitted that they have had their part in thinning out the grouse population. Most sportsmen realize that if they kill one bird in a hundred, only ninety-nine are left; game population is as subject to arithmetical laws as is any other thing. For the most part our sportsmen have shown themselves to be keenly interested in the welfare of the birds and in many sections have refused to kill them when they noted their scarcity. It has been very gratifying to note this, because it indicates that the real sportsman of today honestly cares more for the live birds than he does

for dead ones—a thing that many a member of the Audubon Society might not admit! Of course there are, and regrettably always will be, those "hogs" who would gluttonously kill the last individual of any species of bird, but it was noticeable in a recent tour of the hunting camps of the State that the sportsmen had a genuine personal interest in the grouse. The letters which come to the offices of the Game Commission also indicate the most enthusiastic interest in their immediate protection.

The greatest cause for the decrease of grouse seems to have been the lateness, chillness, and irregularity of the rearing season. Evidence is at hand that in some sections nests were actually flooded when placed in low situations. Examination of sets of eggs has disclosed the fact that numbers of nests were deserted when the embryos in the eggs were only half or three-fourths developed. In some cases even second layings of the birds were deserted, due, presumably, to their chilling. One game protector who had under his observation at one time six nests, reports that four were deserted. If a similar proportion of nests throughout the State were thus abandoned, the diminution of the local population of the birds is easily understood. This chill weather affected not only the eggs in the nest, but doubtless also took away a great many young birds just hatched, since they are at that stage of development, of a delicate constitution, and cold, wet periods of long duration may have killed even half-grown birds. Incidentally, this cold season has been a menace also to Bobwhites, Ring-necked Pheasants and Wild Turkeys—notably the last named species.

As a direct result of the cold spring, insect-life was not as abundant as usual. During the comparatively short period of normal grouse-egg hatching, when the young birds demand certain particular foods, these foods were scarce. Ants' eggs, for instance, are an important food of the downy chicks, and observers in several regions agree that such food as this was either almost wanting or unavailable. Nymph grasshoppers were not as abundant as usual, and many cater-

pillars which feed commonly on low vegetation and which the young grouse capture, were rare. Young birds which might successfully have weathered the cold season with sufficient food, could not do so in an under-nourished state. And many young birds which might have weathered the cold season even in a half-starved state, certainly fell easy prey to vermin as a result of their weakness.

Due to the recent report of some disease in certain sections of the bird's range, many observers have naturally laid the decrease in the Pennsylvania birds to this factor. Examination of the bodies of local specimens so far shows however, that if any disease occurs in Pennsylvania grouse, it is not the scourge generally known as *grouse disease.* Futhermore, there is little evidence otherwise that our birds have suffered from disease. Not one of the many observers and game protectors queried has spoken of finding dead birds in emaciated condition or live birds in a drowsy stupor which would indicate ill health, and all birds observed this season were obviously in exceptionally fine condition. Examination of specimens which have come into my own hands has proved that the birds which remain are in very good health. Their bodies were sturdy and fat and their digestive systems in excellent normal condition. And whatever may be the reason for the bird's decrease, food conditions during the past fall are certainly not to blame, because if ever there was an abundance of various favorite foods such as berries, beechnuts, wild grapes, mast and browse, there was an abundance of such food at that time.

Predatory animals, of course, have been responsible to the usual degree in decimating the grouse population. Reports of the Game Commission force indicate, however, that very few instances of killed-grouse remains have come to their attention. It is well known to all naturalists that any carnivorous mammal or bird, after killing a grouse, usually pulls out some of the large wing or tail feathers which are left as an indication of their feast, so that were vermin a very serious menace, such remains would most certainly be found. Of the mammals which prey on grouse, undoubtedly

Bay Lynxes and Gray and Red Foxes have been the most serious offenders, and these animals have been more than usually abundant in some sections. Great Horned Owls and Goshawks have not however, been abundant and are certainly not to blame. Skunks probably caused some damage particularly during the nesting season, and Raccoons, Weasels, Opossums, Red Squirrels and stray house-cats took their usual toll. All in all, however, it seems only fair to lay chief blame on the cold nesting and early rearing season, which has been, as all observers will agree, unusually severe.

Even in facing this discouraging situation, there is a compensation in that although we have comparatively very few birds, all that ar eleft are in exceptionally fine condition, being for the most part fully grown birds whose hardiness is principally responsible for their present existence. This means that with a favorable nesting season this spring, the young grouse will be exceptionally sturdy ones, and we have no reason to be disheartened provided that the greatest possible protection is given the birds. Bird-lovers should make certain that grouse in their region are well provided with food and cover. Wandering house-cats should, by all means, be killed. These vermin are always a menace and are not beautiful or interesting as some of our native predatory mammals are.

A State-wide closed hunting season on grouse is to be strongly recommended; this will give the birds two undisturbed nesting seasons. It is most gratifying to find that all far-seeing sportsmen in the State are heartily in favor of such a closed season. Some objectors to such a closed season are to be heard, of course; and we all understand the attitude of the man who happens to have seen an unusually large number of birds during the past season, and who feels that no closed season is necessary. But the sportsman who kills game birds realizing their rarity, or who refuses to support his State's laws to the best of his ability, even though his own personal liberties are somewhat curbed, is of course, defeating his own best interests. The man who knows the grouse needs a closed season, and still clamors for his an-

nual kill is just a "hog"—that's all, and not a real sportsman.

Whatever legislation may be enacted, however, may we not fairly expect our enlightened sportsmen, ornithologists, and lovers of the out-doors to combine in an effort to bring these splendid birds back to their former abundance? Never, I believe, will the men of this Commonwealth permit this magnificent bird to join the phantom ranks of the Passenger Pigeon, Labrador Duck, and Eskimo Curlew.

A FEW SPRINGTIME FLOWERS.

By Mary Hovey.

Hepatica, Hepatica, Hepatica or (Hepatica, triloba) of Gray is really our first spring flower, although I have known anemone and spring beauty to come at this time. Hepatica's last year's leaves stay on all winter and show us where to look for our earliest blossoms. On the lake shore, where the icy winds blow from off the northern waters, these dainty blossoms grow in sheltered ravines. Farther west the flowers may be found in gently sloping patches of woods with trees for their protection. Looking among the dead leaves on a late March day one may find, close to the trees, little fuzzy balls, just starting to uncurl. In three or four days or a week, according to the weather, there will be representations of tiny rosebuds, then a few days of warm sunshine and here are lilac, pink, or white sepals, though they look like petals, forming the blossom.

Bloodroot, Indian Paint, Red Puccoon, (Sanguinania Canadens) a neighbor grows beside trees as does the hepatica. It may be found in small patches among the sere leaves. Its name suggests a color which a bird that comes about this time, the ruby crowneed kinglet, wears. But the plant shows a deeper shade in its roots when they are broken off.

Go to the woods to see spring beauty or Claytonia, (Claytonia Virginica), in all its loveliness. If picked it wilts right away but the great patches of tiny pink flowers make an unforgetable sight, wee ground apple blossoms before the trees are in bloom.

Rue-Anemone, (Syndesnon thalictroides) — Thalictrum enemonoides, of Gray—is more common than the true enemonie (Anemone quinquefolia). The name is taken from the Greek story of Venus and her lost lover Adonis. According to fable this little flower tells of the wind's coming in the first days of spring and Pliny said that the breezes unfolded its blossoms.

In the swamps we find buttercups and also in the meadows. (Ranunculus acris) or common meadow buttercup, is the one most of us know though there are numerous other kinds. I have spent many days among them and wished some kindly naturalist would come from the prairie and help me to become acquainted with the different species. One of my earliest memories was a field of these blossoms and violets mingling with the warm spring sunshine, and the joy of being a child, alive and free to roam on a wondrous awakening day.

Shooting star, American cowslip, Pride of Ohio, (Dodecatheon Meadia), is a western flower growing tall beneath trees and in meadows. My childhood's days were spent on the lake shore so I did not encounter this blossom until we moved to a suburb west of the city. Then I found the star like flowers pointing upward.

Wild or spotted geranium, Crane's-Bill or Alum-root, (Geranium maculatum), brings back early memories. These blossoms, lifting up above their wealth of leaves look like a crane standing on one foot.

Then comes the wild blue phlox, (Phlox divanicata), a sea of turquois in the woods. It is chilldhood's memory of beauty, a contrast to winter's bare branches at a time when the trees are just beginning to be green.

Violets (Viola), a welcome to our best beloved springtime flower. Who does not know the common meadow violet and who does not love it? Many there are who ignore all the rest in Nature's wild garden but they would be ashamed to overlook the violet. From the movie fan to the lyrical singer, all greet this little flower. It connects the blossoming world with humanity. If man is willing, it directs and guides him to rarer flowers and thus creates a desire to know more about life's beauties.

The violet is to the flower world what the robin is in the bird world or the swallow-tail butterfly in that realm. Ever wellcome, suggestions of hope and joy, and of cheer.

So bloom best known, best beloved flower, and unite humanity with universal beauty for without you our world of blossoms would be void.

The American Midland Naturalist

PUBLISHED BI-MONTHLY BY THE UNIVERSITY
OF NOTRE DAME, NOTRE DAME, INDIANA

Vol. IX. MAY, 1925. No. 8

THE FLORA OF AN HISTORIC WALL.

(With a special note of *Pellaea atropurpurea.*)

BY DONALD CULROSS PEATTIE.

On my way up to see Father Tondorf, the learned seismologist of Georgetown University, my eye was caught by a refreshing mass of green along the old retaining wall of the University's athletic field. I stopped and examined what it might be that made so brave a show in this dreary month and found it to be a fern exceedingly rare around Washington, the cliff brake, *Pellaea atropurpurea.* As I looked I became aware that the whole wall was alive with it. Most of the chinks and crannies, and there are many such in the oldest third of the quarter-of-a-mile wall, were filled with the fern. I should estimate the total number of this fern at three thousand individuals. The only other station in this region which I know is in the old city of Alexandria, Virginia.

The cliff brake is a favorite of those who know it on accounts of its beautiful purple stems and pale, leathery pinnae. I have found it on a sheer precipice of igneous rock at Chimney Rock, Rutherford County in mountainous North Carolina. It is more rarely associated with densely populated districts like Georgetown.

I have searched such standard books as I have at hand, and nowhere do I find mention of the fact that the cliff brake

is an evergreen fern. In this climate, at least, it would seem to be so, however. In winter condition I found it wholly green, although its pinnae had somewhat curled in, probably for protection after the manner of resurrection and lip ferns.

The newer two thirds of the wall, or at least what I believe to be the newer, are not retaining walls and hence have little earth in their chinks. The chinks, too, are much fewer, due to better masonry. For these reasons and because of the time element, there are far fewer of the cliff brakes on the new walls, although they are more abundant than any other of the plants I found there.

There is one other fern on the wall, *Woodsia obtusa*, which is common in this region but rare on the wall, just as the cliff brake is common on the wall but rare elsewhere in this vicinity. Poison-ivy of the climbing sort was plentiful, and among vines there was also trumpet-creeper, in pod, and star-cucumber. Probably only two species were deliberately planted; they were English ivy and *Parthenocissus tricuspidata* var. *Veitchii*.

Just as the old university with its ecclesiastical air and its chimes and great walls has about it something old-world, so the flora of that wall is also largely an old-world flora as is evidenced from the list of plants appended here.

There is a little of some Carex with thick ribbon-like leaves and a Muehlenbergia which was producing bulblets in the lower axils. There were fewer lichens and mosses than might have been expected, and none were in condition to identify.

I list the species or genera I was able to recognize in winter state.

Pellaea atropurpurea, Cluff Brake
Woodsia obtusa
*Chaetochloa sp. Foxtail
Muehlenbergia sp.
Carex sp.
*Rumex crispus, Curly Dock
*Polygonum convolvulus, Bindweed
Acalypha virginica, Three-seeded Mercury
Rhus radicans, Poison-Ivy
*Hibiscus syriacus, Althea, "Rose-of-Sharon"
*Parthenocissus tricuspidata var. Veitchii. Boston Ivy
Viola sp.., Violet
*Hedera helix, English Ivy
*Paulownia imperialis, Princess Tree
Tecoma radicans, Trumpet Creeper
*Pantago lanceolata, English Plantain
*Lonicera japonica, Japanese Honeysuckle
Sicyos angulatus, Star Cucumber
Solidago spp., Golden Rod
Aster spp., Aster
Ambrosia trifida, Ragweed
Lactuca sp.
*Sonchus sp. Sow Thistle

---

* Denotes old-world species.

Donald Culross Peattie,
Lee Heights, Rosslyn,
Virginia.

FEB. 8, 1925

H. PTERIDOPHYTA.

N. M. GRIER.

(*Continued from the January Issue*)

OPHIOGLOSSACEAE.

Botrychium dissectum Spreng. Cut-leaved Grape-Fern or Moon Wort. Coppice, Jones Marsh, 1st, 2nd lakes. C.S.H. —G.H.H.

Botrychium obliquum Muhl. Ternate Grape-fern. Coppice. Jones Marsh. C.S.H.—N.M.G.

Botrychium virginianum L. Virginia Grape-fern. Jones' Woods, High Hill. C.S.H.—N.M.G.

OSMUNDACEAE.

Osmunda cinnamomea L. Cinnamon Fern. Moist woods, gardens, C.S.H.—N.M.G.

Osmunda claytoniana L. Clayton's Fern. Moist woods, C. S.H.—N.M.G.

Osmunda regalis L. Royal Fern. Coppice of Jones Marsh. C.S.H.—C.E.

POLYPODIACEAE.

Adiantum pedatum L. Maiden-hair or Lock-hair Fern. Moist, rich woods. C.S.H.—N.M.G.

Anchistea virginica (L) Presl. Virginia Chain Fern. C.S.H. —J.A.H.

Asplenium platyneuron Oakes... Ebony Spleenwort. De Forest Estate, C.S.H.—G.H.H.

Athyrium Filix-femina (L) Roth. Lady Fern. Woods near 1st lake—N.M.G.

Dennstaedtia punctiloba (Mich.) Moore. Hay Scented Fern. Moist woods, C.S.H.—N.M.G.

Dryopteris aristatum var. Clintoniana. Clinton's Fern. C. S.H.—N.M.G.

Dryopteris boottii (Tuckerm.) Underw. Boott's Shield Fern. Vicinity C. S. H.—J.A.H.

Dryopteris marginalis L. Evergreen Wood Fern. Moist rich woods. C.S.H.—G.H.H.

Dryopteris noveboracensis. Sw. New York Fern. Woods near 1st lake.—N.M.G.

Dryopteris Phegopteris (L.) C. Chr. Long Beach Fern. C. S.H.—N.M.G.

Dryopteris simulata. Davenp. Dodge's Shield Fern. Vicinity C.S.H.—C.E.

Dryopteris spinulosa. (Muell.) Kuntze. Spinulose Shield Fern. C.S.H.—N.M.G.

Dryopteris Thelypteris L. W. Marsh Shield Fern. Near salt marsh, C.S.H.—N.M.G.

Filix Fragilis (L.) Underwood. Brittle Fern. C.S.H.—N.M.G.

Lorinseria areolata (L.) Prest. Net-veined Chain Fern. Between 1st and 2nd lakes, C.S.H.—G.H.H.

Matteucia Struthiopteris (L.) Todaro. Ostrich Fern. De Forest Estate, C.S.H.—N.M.G.

Onoclea sensibilis L. Sensitive Fern. Moist Localities. C. S.H.—N.M.G.

Phyllites scolopendrium (L.) Newm. Hart's Tongue. De Forest Estate, C.S.H.—N.M.G.

Polystichum acrostichoides (Mch.) Schott. Christmas Fern. Rocky woods, C.S.H.—N.M.G.

Polystichum lonchitis L. Holly Fern. C.S.H.—N.M.G.

Polypodium vulgare L. Common or Golden Polypody. Rocky banks, C.S.H.—N.M.G.

Pteridium aquilinum (L.) Kuhn. Brake. Bracken. Pine barrens, St. James, L. I.; C.S.H.—N.M.G.

MARSILIEACEAE.

Marsilea quadrifolia L. European Marsilea or Pepper wort. Established at Fourth lake, and estates, C.S.H.—N.M.G.

SALVINIACEAE.

Azolla caroliniana Willd. Carolina Azolla. Estates vicinity, C.S.H.—N.M.G.

---

* In preparing this and following sections of the manuscript I am indebted for the aid of former students, Mrs. Christine Ruth Grier, Miss Gail Holliday, Miss Susan Green, Miss Emma Kemp, Miss Myrtle Waterfall.

Salvinia natans (L.) All. Salvinia. Floating Moss. Estates. vicinity C.S.H.—N.M.G.

EQUISETACEAE.

Equisetum arvense L. Field Horsetail. Marsh, C.S.H.—N.M.G.

LYCOPODIACEAE.

Lycopodium carolinianum L. Carolina Club-moss. L. Ronkonkema region, L. I. Ferguson (2).

Lycopodium complanatum L. Trailing Christmas-green. Ground-pine. Moist woods, C.S.H.—N.M.G.

Lycopodium inundatum L. Bog or Marsh Club-moss. C.S.H.—N.M.G.

Lycopodium lucidulum. Michx. Shining Club-moss. Havemeyer Estate, near Oyster Bay—N.M.G.

Lycopodium obscurum L. Ground-pine. Havemeyer Estate, near Oyster Bay.—N.M.G.

SELAGINELLACEAE.

Selaginella apus (L) Creeping Selaginella. Fern Belt in Salt Marsh. C.S.H.—H.S.C.

ISOETACEAE.

Isoetes tuckermani A. Br. Tuckerman's Quillwort. Lake Ronkonkema, L. I.—N.M.G.

EMBRYOPHYTA SIPHONOGAMA. (SPERMATOPHYTA)

I. GYMNOSPERMAE.

PINACEAE.

Abies balsamea (L) Mill. Balsam Fir. Tiffany Estate, C.S.H.—G.H.H.

Abies Picea (L) Lindley. Norway Spruce. De Forest Estate, C.S.H.—N.M.G.

Chamaecyparis thyoides L. Southern White Cedar. Tiffany Estate, C.S.H.—N.M.G.

Juniperus communis L. Juniper. Eugenics Record office, C.S.H.—N.M.G.

Juniperus communis var. *depressa*. Eugenics Record office grounds, C.S.H.—N.M.G.

Juniperus virginiana L. Red Cedar. Near Eugenics Record office, C.S.H.—N.M.G.

Larix laricina Koch. American Larch. Near Cold Spring Harbor Village.—G.H.H.

Pinus rigida Mill. Pitch Pine. Woods near C.S.H.—N.M.G.

Pinus Strobus L. White Pine. Weymouth Pine. Moist woods, C.S.H.—N.M.G.

Taxodium distichum L. Bald Cypress. Matheson Estate, Lloyds Point, L. I.—N.M.G.

Thuja occidentalis L. Arbor Vitae. Tiffany Estate, C.S.H. —N.M.G.

Tsuga canadensis (L) Carr. Hemlock. Tiffany Estate, C.S. H.—N.M.G.

TAXACEAE.

Taxus canadensis. Marsh. American Yew. De Forest Cemetery. C.S.H.—N.M.G.

II. ANGIOSPERMAE.

MONOCOTYLEDONES.

TYPHACEAE.

Typha angustifolia L. Narrow-Leaved Cat-tail. Brackish marsh, C.S.H.—N.M.G.

Typha latifolia L. Broad-leaved Cat-tail. Fresh water marsh, C.S.H.—N.M.G.

SPARGANIACEAE.

Sparganium androcladum (Eng.) Morong. Branching Bur-Reed. C.S.H.—N.M.G.

Sparganium lucidum Fernald. Shining-fruited Bur-reed. Muddy shore 1st lake, C.S.H.—N.M.G.

Sparganium simplex. Huds. Simple-stemmed Bur-reed. Black-weed. Mud flats, 2nd lake, C.S.C.—N.M.G.

ZANICHELLIACEAE.

Potamogeton alpinus. Bubs. Northern Pondweed. C.S.H.— N.M.G.

Potamogeton crispus L. Pondweed. C.S.H.—N.M.G. Grout.

Potamogeton oakesianus, Oakes' Pondweed. C.S.H.—Jelliffe.

Potamogeton pusillus L. Small Pondweed. 2nd lake, C.S.H. —N.M.G.

Ruppia maritima L. Sea or Ditch-grass. West shore, C.S.H. —N.M.G.

ZOSTERACEAE.

Zostera marina L. Eel-grass. Shores of C.S.H.—N.M.G.

SCHEUCHZERIACEAE.

Triglochin maritima L. Sea-side Arrow-grass. Marsh, C.S. H.—N.M.G.

ALISMACEAE.

Alisma subcordatum Raf. American Water plantain. Woodbury Bog, Woodbury, L. I.—G.H.H.

Sagittaria engelmanni J. Engelmann's Arrow-head. L. Ronkonkema. (Ferguson List.)

Sagittaria graminea. Michx. Grass-leaved Sagittaria. C.S.H. vicinity—N.M.G.

Sagittaria latifolia Willd. Broad-leaved Arrow-head. C.S.H. vicinity.—J.A.H.

Sagittaria rigida Pursh. Sessile-fruited Arrow-head. Hodenpyl estate, Locust Valley, L. I.—N.M.G.

VALLISNERIACEAE.

Philotria canadensis (L) Mchx. Water-weed. 1st lake, C. S.H.—N.M.G.

GRAMINEAE.

Agropyron repens Beauv. Couch-grass. Roadside, Fish Hatchery, C.S.H.—N.M.G.

Agropyron sativum Lam. Dump, escaped from cultivation. C.S.H.—N.M.G.

Agrostis alba L. Red-top. Common C.S.H.—D.S.J.

Agrostis hyemalis B. S. P. Rough Hair-grass. Near railway station, C.S.H.—G.H.H.

Agrostis maritima Lam. Dense-flowered Bent-grass. North Thicket, Jones Marsh.—G.H.H.

Agrostis perennans (Walt.) Tuckerm. Upland Bent-grass. C.S.H.—J.A.H.

Alopecuris sp. L. Fox tail. Jones Marsh, C.S.H.—N.M.G.

Ammophila arenaria (L) Sea Sand-reed. Upper Beach, C.S. H.—N.M.G.

Andropogon furcatus Muhl. Forked Beard-grass. Hempstead Plains, Hicksville, L. I.—N.M.G.

Andropogon virginicus L. Virginia Beard-grass. C.S.H. vicinity.—J.A.H.

Anthoxarthum adoratum L. Sweet Vernal-grass. Near Blackford Hall, C.S.H.—G.H.H.

Aristida tuberculosa. Nutt. Sea-beach Triple-awned Grass. C.S.H.—Ferguson (2) J.A.H.

Arrhenatherum elatius (L) Beauv. Oat-grass. C.S.H.—J. A.H.

Avena sativa Linn. Oats. Dump, C.S.H.—N.M.G.

Bromus nordeaceus L. Soft Chess. C.S.H. vicinity—J.A.H.

Bromus racemosus L. Upright Chess. C.S.H. vicinity.—J. A.H.

Bromus tectorum L. Downy Brome-grass. C.S.H.—J.A.H.

Calamogrostis canadensis, Beauv. Blue-joint Grass. Lake Ronkonkema, L. I.—G.H.H.

Capriola Dactylon. Pers. Bermuda-grass. Jones Marsh, C. S.H.—C.E.

Cenchrus tribuloides L. Bur-grass.C.S.H.—N.M.G.

Chaetochloa glauca (L) Scrib. Yellow Foxtail. Common C.S.H.—G.H.H.

Chaetochloa viridis (L) N. Green Foxtail-grass. C.S.H. vicinity.—J.A.H.

Cinna arundinacea L. Sweet Reed-grass. C.S.H.—N.M.G.

Dactylis glomerata L. Orchard-grass. Cock's foot. Lab. grounds, C.S.H.—C.E.

Danthania spicata. Beauv. Common Wild Oat-grass. Hills above lakes. C.S.H.—N.M.G.

Deschampsia flexuosa (L) Trin. Wavy Hair-grass. Hills above lakes. C.S.H.—G.H.H.

Diplachne fascicularis Beauv. Clustered Salt-grass. C.S.H. —N.M.G.

Distichlis spicata. Greene. Marsh Spike-grass. Salt Marsh. C.S.H.—N.M.G.

Echinochloa Crus-galli. Beauv. Barnyard-grass. Hicksville near depot.—G.H.H.

Eleusine indica (L) Gaertner. Wire-Grass. C.S.H. vicinity.— D.S.J.

Elymus virginicus L. Sandspit. Terrell-grass. G.S.H.

Eragrostis Eragrostis (L) Karst. Love-grass. Sandspit, C. S.H. vicinity.—J.A.H.

Eragrostis pectinacea Steud. Purple Love-grass. Near Railroad Station, C.S.H.—G.H.H.

Eragrostis pilosa Beauv. Small Tufted Love-grass. Salt Marsh, C.S.H.—G.H.H.

Festuca elatior L. Tall or Meadow Fescue-grass. C.S.H. Roadsides.—G.H.H.

Festuca ovina L. Sheep's Fescue-grass. C.S.H. vicinity. —G.H.H.

Homalocenchrus oryzoides (L) Rice Cut-grass. C.S.H. vicinity.—J.A.H.

Homalocenchrus virginicus (Willd.) Britton. White Grass. Jones Marsh, C.S.H.—C.E.

Lolium perenne L. Ray-grass. Near Catholic church, Huntington.—G.H.H.

Muhlenbergia mexicana (L) Trin. Satin-grass. C.S.H.—J.A.H.

Nothoholcus lanatus (L) Nash. Velvet-grass. Meadow or Woolly Soft-grass. Pastures, C.S.H. vicinity.—G.H.H.

Panicularia canadensis (Michx) Kuntze. 1st lake north of St. John's church. C.S.H.—G.H.H.

Panicularia nervata (Willd) Kuntze. Meadow-grass. C.S.H. —J.A.H.

Panicum Boscii Poir. Bosc's Panic-grass. C.S.H. vicinity—Jelliffe.

Panicum capillare L. Witch-grass. R. R. west of depot, C. S.H.—H.

Panicum clandestinum L. Corn Grass. R. R. west of depot and Jones Marsh. C.S.H.—G.H.H.

Panicum depauperatum L. Starved Panic-grass.—C.S.H.—J.A.H.

Panicum dichatomum L. Forked Panic-grass. R. R. west of depot. C.S.H.—G.H.H.

Panicum linearifolium Scrib. Low White-haired Panic-grass. C.S.H.—J.A.H.

Panicum meridionale Ashe. Matting Panic-grass. Salt Marsh, C.S.H.—G.H.H.

Panicum microcarpon Muhl. Barbed Panic-grass. R. R. west of depot. C.S.H.—G.H.H.

Panicum tennesseense Ashe. Tennessee Panic-grass. C.S.H. vicinity.—J.A.H.

Panicum virgatum L. Switch-grass, Wild Red-Top. C.S.H. vicinity.—N.M.G.

Panicum wilcoxianum Wilcox's Panic-grass. C.S.H. vicinity. —N.M.G.

Phalaris Canariensis L. Canary or Bird-seed-grass. Waste places. C.S.H.—N.M.G.

Phleum pratense L. Timothy. Herd's grass. Laboratory grounds, C.S.H.—N.M.G.

Phragmites Phragmites Karst, Read. Common Reed-grass. Gilgo Beach, L. I.; Jones Marsh, C.S.H.—N.M.G.

Poa annua (L) Dwarf Meadow-grass. Low spear-grass, C. S.H.—J.A.H.

Poa compressa L. Wire-grass. Sandspit, Roadsides, C.S.H.— N.M.G.

Poa pratensis L. Kentucky Blue-grass. Fields, Cold Spring Harbor, C.S.H.—N.M.G.

Savastana odorata (L) Scrib. Holy Grass Seneca-grass, C.S.H.—Jelliffe.

Schizachyrium scoparium (Michx) Nash. Broom Beard-grass. Hempstead Plains, Hicksville, L. I.—N.M.G.

Sorghastrum nutans (L) Nash. Indian-grass. C.S.H.—N. M.G.

Spartina cynosuroides Marsh. Salt Reed-grass. Lloyd's Point, C.S.H.—N.M.G.

Spartina patens Muhl. Salt-meadow grass. Salt Marsh, C. S.H.—N.M.G.

Spartina stricta (Ait) Roth. Salt Marsh-grass. Salt Marsh, C.S.H.—N.M.G.

Sporobolus asper Kunth. Long-leaved Rush-grass. Roadside on Sea Beach, C.S.H.—G.H.H.

Syntherisma sanguinale (L) Dulac. Large Crab-grass. Finger grass.—N.M.G.

Tridens flava L. Hitchc. Tall Red-top. R. R. West of depot, C.S.H.—G.H.H.

Zea Mays, Linn. Escaped from Cultivation, C.S.H.—N.M.G.

CYPERACEAE.

Carex abscondita Mackenzie, Thicket Sedge Ferguson (2), C.S.H.—J. A. Ferguson.

Carex Asa Grayi Bailey. Gray's Sedge, C.S.H. vicinity.—J. A.H.

Carex canescens L. Silvery or Hoary Sedge, C.S.H.—J.A.H.

Carex cephalophora Muhl. Oval-headed Sedge, C.S.H.—J.A.H.

Carex crinita Lam. Fringed Sedge. Sickle Grass. C.S.H.—Jelliffe.

Carex digitalis Willd. Slender Wood Sedge, C.S.H.—J.A.H.

Carex flexuosa Muhl. Slender-stalked Sedge. Vicinity C.S.H. —J.A.H.

Carex folliculata L. Long Sedge C.S.H.—N.M.G.

Carex gynandra Schwein. Nodding Sedge. C.S.H.—J.A.H.

Carex hormathodes Fernald. Marsh Straw Sedge. Fresh and Brackish marshes, C.S.H.—Jelliffe.

Carex Hystricins. S. Porcupine Sedge. Bog, C.S.H.—G.H.H.

Carex interior Bailey. Inland Sedge. C.S.H.—J.A.H.

Carex intumescens Rudge. Bladder Sedge, C.S.H.—G.H.H.

Carex laxiflora Lam. Loose-flowered Sedge. Vicinity, C.S.H. —J.A.H.

Carex lurida Wohl. Sallow Sedge. Vicinity, C.S.H.—J.A.H.

Carex pennsylvanica Lam. Pennsylvania Sedge. Vicinity, C. S.H.—J.A.H.

Carex rosea Schk. Stellate Sedge. Vicinity C.S.H.—J.A.H.

Carex scabrata Schw. Rough Sedge. Vicinity C.S.H.—J.A.H.

Carex scoparia canadensis Fernald. Pointed Broom Sedge. Vicinity, C.S.H.—J.A.H.

Carex sterilis Willd. Inland Sedge. C.S.H.—G.H.H.

Carex stipata Muhl. Awl-fruited Sedge. Vicinity C.S.H.—J. A.H.

Carex straminea Willd. Straw Sedge. Dog- grass. Vicinity C.S.H.—Jelliffe.

Carex stricta Lam. Tussock Sedge. Vicinity C.S.H.—C.E.

Carex tenuiflora Wahl. Sparse-flowered Sedge. Vicinity C. S.H.—N.M.G.

Carex tribuloides. Wahl. Blunt Broom Sedge. Vicinity, C.S. H.—J.A.H.

Carex virescens Muhl. Ribbed Sedge, C.S.H.—J.A.H.

Carex vulpinoidea Mchx. Fox Sedge. Jones Marsh, C.S.H.— C.E.

Cyperus diandrus Torr. Low Cyperus. Vicinity, C.S.H.—J. A.H.

Cyperus erythrorrhizus (L) Muhl. Red-rooted Cyperus. Edge Salt marsh, C.S.H.—N.M.G.

Cyperus filiculmos. Vahl. Slender Cyperus. Sand spit, ice house site, C.S.H.—N.M.G.

Cyperus flavescens L. Yellow Cyperus. Kettle Hole, near L. Ronkonkema, L. I.—N.M.G.

Cyperus Grayi Torr. Gray's Cyperus. Vicinity, C.S.H.—J. A.H.

Cyperus speciosus Vahl. Michaux's Cyperus. Vicinity, C.S.H. J.A.H.

Cyperus strigosus L. Straw-colored Cyperus. Salt Marsh, C.S.H.—G.H.H.

Dulichium arundinaceum (L) Britt. Glen Cove. L. I.—Jelliffe.

Eleocharis acicularis (L) R. and S. Needle, or Least, Spike-rush. Vicinity, C.S.H.—J.A.H.

Eleocharis melanocarpa Torr. Black fruited spike-rush,—N.M.G.

Eleocharis olivacea Torr. Bright Green Spike-rush. Salt Marsh, C.S.H.—N.M.G.

Eleocharis palustris (K) Roem and Schult. Creeping Spike-rush. Glen Cove.—Jelliffe.

Eleocharis rostellata. Torr. Beaked Spike-rush. Salt Marsh, C.S.H.—C.E.

Eleocharis tenuis (Willd.) Schultes. Slender Spike-rush. N. W. Thicket, Jones' Marsh, C.S.H.—C.E.

Eriophorum tenellum Nutt. Rough Cotton-grass. L. Ronkonkema.—N.M.G.

Eriophorum sp. Marsh at head of L. Ronkonkema.—N.M.G.

Eriophorum virginicum L. Virginia Cotton-grass, C.S.H. vicinity.—Jelliffe.

Fimbristylis autumnalis (L) Roem and Schult. Slender Fimbristylis, Glen Cove.—Jelliffe.

Rynchospora alba. Vahl. White Beaked-rush Marsh. At head of L. Ronkonkema.—N.M.G.

Rynchospora glomerata Vahl. Clustered Beaked-rush. Marsh at head of L. Ronkonkema.—G.H.H.

Scirpus americanus. Pers. Three-square, Foot of bank. Salt marsh, C.S.H.—N.M.G.

Scirpus atrovirens Muhl. Dark-green Bulrush. Glen Cove.—D.S.

Scirpus cyperinus (L) Kunth. Wool-grass. Jones Marsh, N. W. Thicket—C.E.

Scirpus nanus Spring. Salt marsh, C.S.H.—N.M.G.

Scirpus paludosus A. Nelson. Prairie Bulrush. Vicinity, C.S.H.—J.A.H.

Scirpus polyphyllus Vahl. Leafy Bulrush, C.S.H.—Jelliffe.

Scirpus robustus Pursh. Salt Marsh Bulrush. Jones Salt Marsh, C.S.H.—N.M.G.

Scirpus subterminalis Torr. Water Club-rush, C.S.H.—Jelliffe.

Scirpus sylvaticus L. Wood Bulrush or Clubrush.—G.H.H.

Scirpus validus Vahl. American Great Bulrush. Mat-rush. Glen Cove.—Jelliffe.

Scleria pauciflora Muhl. var. caroliniana. Papillose Nut-rush. Hempstead Plains, Hicksville.—G.H.H.

Scleria triglomerata. Michx. Tall Nut-rush. Hempsted Plain, Hicksville.—G.H.H.

Stenophyllus capillaris, Brit. Hair-like Stenophyllus. Hill west of R. R. depot, C.S.H.—G.H.H.

ARACEAE.

Acorus Calamus L. Sweet Flag. Jones Marsh, C.S.H.—N.M.G.

Arisaema triphyllum (L) Schott. Jack-in-the-pulpit. Jones woods, C.S.H.—N.M.G.

Spathyema foetida (L) Raf. Skunk cabbage. Bog. 1st. lake, C.S.H.—N.M.G.

LEMNACEAE.

Lemna minor L. Lesser Duck-weed—Jelliffe.

Spirodela polyrhiza (L) Schleid. Greater Duckweed, 2nd lake. Cold Spring Harbor.—Jelliffe.

XYRIDACEAE.

Xyris caroliniana Small. Carolina Yellow-eyed Grass. Kettle hole near Lake Ronkonkema, L. I.—N.M.G.

Xyris flexuosa Muhl. Slender Yellow-eyed Grass. Vicinity C.S.H.—N.M.G.

ERIOCAULACEAE

Eriocaulon septangulare With. Seven-angled Pipewort. L. Ronkonkema, Mineola, L. I.—N.M.G.

COMMELINACEAE.

Commelina communis L. Asiastic Day-flower. Roadsides C.S.H.—N.M.G.

Commelina virginica. L. Virginia Day-flower. C.S.H.—N.M.G.

PONTEDERIACEAE.

Pontederia cordata L. Pickerel-weed. L. Ronkonkema, L. I.—N.M.G.

JUNCACEAE.

Juncoides carolinae (S. Wats.) Kuntze. Hairy Wood-rush.—Jelliffe.

Juncoides campestre (L) Kuntze. Common Wood-rush. Vicinity, C.S.H.—J.A.H.

Juncus acuminatus Mx. Sharp-fruited Rush. Vicinity, C.S.H.—J.A.H.

Juncus brachycephalus Buch. Small-headed Rush. Vicinity C.S.H.—G.H.H.

Juncus bufonius L. Toad Rush. Vicinity C.S.H.—J.A.H.

Juncus canadensis Gay. Canada Rush. Salt Marsh, C.S.H.—N.M.G.

Juncus effusus L. Common Rush. Vicinity C.S.H.—N.M.G.

Juncus Gerardi Loisel. Black-grass. Salt Marsh, C.S.H.—N.M.G.

Juncus Greenei Oakes and Tuckermann. Greene's Rush. Hempstead Plains, L. I.—N.M.G.

Juncus tenuis Willd. Slender Rush. Yard Rush. Hempstead Plains.—N.M.G.

MELANTHACEAE.

Chamaelerium sp. C.S.H.—G.H.H.

Chroosperma sp. C.S.H.—G.H.H.

Melanthium latifolium Lorr. Crisped Bunch-flower.—N.M.G.

LILIACEAE.

Aletris farinosa L. Star-grass Ague. Hempstead Plain, Hicksville.—N.M.G.

Allium canadense L. Meadow Garlic.—Jelliffe.

Allium tricoccum Ait. Wild Leek. C.S.H., on roadsides.—N.M.G.

Allium vineale L. Wild Garlic. C.S.H., on roadsides.—N.M.G.

Hemerocallus fulva L. Day Lily. Roadsides, C.S.H.—N.M.G.

Lilium canadense L. Wild Yellow Lily.—Jelliffe.

Lilium philadelphicum L. Wood Lily. Pine Barrens near St. James, L. I.—N.M.G.

Lilium superbum L. Turk's Cap Lily. Hodenpyl Estate, Locust Valley, L. I.—N.M.G.

Lilium tigrinum Ker. Tiger Lily. Roadsides, C.S.H.—N.M.G.

Muscari botryoides (L) Hill. Grape Hyacinth. C.S.H. vicinity.—J.A.H.

Ornithogalum umbellatum L. Star-of-Bethlehem. Summer Snow-flake, Star-Flower.—N.M.G.

Veratrum viride Ait. American White Hellebore. Vicinity of lakes, C.S.H.—N.M.G.

Yucca filamentosa L. Adam's Needle. DeForest Estate, C. S.H., Fish Hatchery.—N.M.G.

CONVALLARIACEAE.

Asparagus officinalis L. Asparagus. C.S.H., vicinity. sandspit —N.M.G.

Polygonatum biflorum Ell. Hairy Solomon's Seal. Jones' Woods, near 1st lake, C.S.H.—N.M.G.

Polygonatum commutatum. (Wait) Ell. Smooth Solomon's Seal, C.S.H.—J.A.H.

Vagnera racemosa (L) Wild Spikenard. Woods, vicinity C. S.H.—N.M.G.

Vagnera stellata (L) Morong. Star-flowered Solomon's Seal. C.S.H.—Jelliffe.

Unifolium canadense (Desf.) Greene. False Lily-of-the-Valley. Woods near 1st lake.—G.H.H.

Uvularia perfoliata L. Perfoliate Bellwort. Vicinity C.S.H. —Jelliffe.

Uvularia sessifolia L. Sessile-leaved Bellwort. Vicinity C. S. H.—J.A.H.

TRILLIACEAE.

Medeola virginiana L. Indian Cucumber-root. Hill above 1st lake, C.S.H.—N.M.G.

Trillium erectum L. Ill-scented Wake-robin. Glen Cove. — Jelliffe.

Trillium undulatum Willd. Painted Wake-robin. Glen Cove. —Jelliffe.

Trillium cernuum L. Nodding Wake-robin. Vicinity C.S.H. —N.M.G.

Trillium grandiflorum (Michx) Salisb. Large-flowered Wake-robin.—N.M.G.

SMILACEAE.

Smilax glauca L. Glaucous-leaved Greenbrier. Woods, C.S.H.—G.H.H.

Smilax herbacea L. Carrion-flower. Woods. Vicinity C.S.H.—Jelliffe.

Smilax rotundifolia L. Greenbrier. Woods. Vicinity, C.S.H.—N.M.G.

AMARYLLIDACEAE.

Hypoxis hisuta (L) Coville Yellow Star-grass. Hempstead Plains near Hicksville—N.M.G.

IRIDACEAE.

Gladiolus sp. Jones' Marsh.—C.E.

Iris prismatica Pursh. Narrow Blue-flag. C.S.H.—N.M.G.

Iris versicolor L. Larger Blue-flag. Salt Marsh, C.S.H.—N.M.G.

Sisyrhinchium angustifolium Muhl. Pointed Blue-eyed Grass.—Jelliffe.

Sisyrhinchium graminoides. Mull. Stout Blue-eyed Grass. Vicinity C.S.H.—J.A.H.

ORCHIDACEAE.

Arethusa bulbosa L. Dragon's Mouth. Oyster Bay.—Jelliffe.

Blephariglottis ciliaris L. Rydb. Yellow-fringed Orchis. Hempstead Plains, Hicksville, L. I.—Jelliffe.

Blephariglottis lacera (Michx.) R. Br. Ragged or Green-fringed Orchis. Moist woods, 1st lake, C.S.H.—N.M.G.

Blephariglottis psycodes (L) Rydb. Smaller purple-fringed Orchis. Oyster Bay.—Jelliffe.

Corallorrhiza maculata Raf. Large Coral-root.—Jelliffe.

Fissipes acaulis (Ait.) Small. Moccasin Flower Stemless Ladies'-Slipper. Bayville Woods about lakes.—N.M.G.

Gymnadeniopsis clavellata (Mchx.) Rydb. Small Green Wood Orchis. Sphagnum Bog, West Side 3rd Lake, C.S.H.—D.S.J.

Ibidium Beckii (Lindl) House. Little Ladies' Tresses, C.S.H.—J.A.H.

Ibidium cernuum (L) House. Nodding or Drooping Ladies' Tresses, C.S.H.—D.S.J.

Ibidium gracile (Bigel) House. Slender Ladies' Tresses, C. S.H.—J.A.H.

Ibidium plantagineum (Raf.) House. Wide-leaved Ladies' Tresses. C.S.H.—D.S.J.

Ibidium praecox (Walt.) House. Grass-leaved Ladies' Tresses C.S.H.—D.S.J.

Limodorum Tuberosum L. Frequent Grass-pink. Calopogon. C.S.H.—D.S.J.

Liparis liliifolia (L) L. C. Rich. Large Twayblade. C.S.H.—D.S.J.

Malaxis unifolia Michx. Green Adder's-Mouth, C.S.H., Oyster Bay—Jelliffe.

Peramium ophioides (Fernald) Rydb. Lesser Rattlesnake Plantain. Vicinity, C.S.H.—N.M.G.

Peramium pubescens (Willd.) Macm. Downy Rattlesnake Plantain. Moist woods near 2nd lake, C.S.H.—N.M.G.

Perularia flava (L.) Farwell. Tubercled Orchis. Small Pale-Green Orchis, Glen Cove.—Jelliffe.

DICOTYLEDONES.

SAURURACEAE.

Saururus cernuus L. Lizard's Tail. Glen Cove—Jelliffe.

JUGLANDACEAE.

Hicoria alba L. Roadsides. White-heart Hickory. Eugenics Record Office grounds, C.S.H.—N.M.G.

Hicoria glabra Spach. Pig-nut Hickory. Thicket in Jones Marsh, C.S.H.—N.M.G.

Juglans cenerea L. Butternut. Roadsides. C.S.H.—N.M.G.

Juglans nigra. L. Black Walnut. Roadsides, C.S.H.—N.M.G.

MYRICACEAE.

Comptonia peregrina (L) Coulter. Sweet Fern. C.S.H. vicinity.—N.M.G.

Myrica carolinensis Mill. Bayberry. De Forest Cemetery. C. S.H.—N.M.G.

Myrica cerifera L. Wax myrtle, C.S.H. vicinity.—N.M.G.

Myrica Gale L. Sweet Gale. C.S.H. vicinity.—N.M.G.

SALICACEAE.

Populus alba L. Aspen. Roadsides, C.S.H.—N.M.G.

Populus balsaminifera L. Carolina Poplar. Vicinity, C.S.H. —N.M.G.

Populus candicans Ait. Balm of Gilead, C.S.H. vicinity.—N.M.G.

Populus grandidentata L. Large-toothed Aspen. Pine Barrens, L.I. Vicinity C.S.H.—N.M.G.

Populus heterophylla L. Swamp Poplar, C.S.H. vicinity.—Jelliffe.

Populus italica Moench. Lombardy Poplar. C.S.H. vicinity.—Jelliffe.

Populus tremuloides Mchx. Quiver-leaf, C.S.H. vicinity.—Jelliffe.

Salix alba L. White Willow. Along streams and roadsides. C.S.H.—N.M.G.

Salix babylonica L. Weeping Willow. Near streams, De Forest Estate. C.S.H.—N.M.G.

Salix discolor Muhl. Pussy Willow. C.S.H. vicinity.—N.M.G.

Salix fragilis L. Crack Willow. C. S.H. vicinity.—N.M.G.

Salix humilis Marsh. Prairie Willow, Hempstead Plain. C. S.H.—N.M.G.

Salix lucida Muhl. Shining Willow. C.S.H. vicinity.—J.H.H.

Salix petiolaris J. E. Smith. Slender Willow. C.S.H. vicinity —J.H.H.

Salix purpurea L. Purple Willow. C.S.H. vicinity.—J.H.H.

BETULACEAE.

Alnus incana (L) Moench. Hoary Alder. E. shore C.S.H.—D.S.J.

Alnus rugosa Spreng. Hazel Alder. Road near fish hatchery. C.S.H.—N.M.G.

Betula lenta L. Cherry Birch. Moist woods, C.S.H.—N.M.G.

Betula lutea Michx. Yellow Birch. Woods near 2nd lake, Fish hatchery Road, C.S.H.—N.M.G.

Betula nigra. L. Red Birch. Oyster Bay.—D.S.J.

Betula populifolia Marsh. American White Birch. Road to Eugenics Record Office.—N.M.G.

Carpinus carolinana Walt. American Hornbeam. Vicinity 1st and 2nd lakes, C.S.H.—N.M.G.

Corylus americana Walt. Hazel-nut. Near 1st lake, C.S.H —N.M.G.

Ostrya virginiana (Hill) Willd. Iron-wood. C.S.H. vicinity. —G.H.H.

FAGACEAE.

Castanea dentata (Marsh) Borkh. American Chestnut. C. S.H. vicinity. Saplings only.—N.M.G.

Fagus grandifolia Ehrb. American Beech. Grounds Eugenics Record Office, C.S.H.—N.M.G.

Quercus alba L. White Oak. Vicinity lakes. C.S.H.—N.M.G.

Quercus coccinea Wang. Scarlet Oak. Huntington Rd., C.S. H.—N.M.G.

Quercus ellipsoidalis Hill. Hill's Oak. Bayville near dunes.—N.M.G.

Quercus illicifolia Wang. Scrub Oak. Pine Barrens, St. James, L. I.—N.M.G.

Quercus imbricaria Mich. Shingle Oak. Hodenpyl Estate, Locust Valiley, L. I.—N.M.G

Quercus marilandica Muench. Barren Oak. Bayville, L. I., on dunes.—N.M.G.

Quercus Muhlenbergii Engelm. Chestnut Oak, Locust Valley, Glen Cove, Oyster Bay.—Jelliffe.

Quercus nigra L. Black-jack Oak. Oyster Bay.—Jelliffe.

Quercus palustris Muench. Pin Oak. Lloyd Point, C.S.H.—N.M.G.

Quercus Phellos L. Willow Oak. Matheson Estate, Lloyd Point, C.S.H.—N.M.G.

Quercus prinoides Willd. Scrub Chestnut Oak. Hempstead Plain, C.S.H. vicinity, Hicksville, L. I.—N.M.G.

Quercus Prinus L. Rock Chestnut Oak. 1st and 2nd lakes. C.S.H.—N.M.G.

Quercus rubra L. Red Oak. 1st and 2nd lakes. C.S.H.—N.M.G.

Quercus stellata Wang. Post Oak. Hempstead Plains, Hicksville, Oyster Bay.—H.S.C.

Quercus velutina Lam. Black Oak, C.S.H. vicinity.—N.M.G.

ULMACEAE.

Celtis occidentalis L. Hackberry, C.S.H. vicinity.—N.M.G.

Ulmus alata Michx. Winged Elm. Hodenpyl Estate, Locust Valley, L. I.—N.M.G.

Ulmus americana L. American Elm. Roadsides, C.S.H. vicinity.—N.M.G.

Ulmus campestris L. English Elm. C.S.H. vicinity.—N.M.G.

Ulmus fulva Mchx. Slippery Elm. Jones woods, C.S.H., Glen Cove, Oyster Bay.—Jelliffe.

MORACEAE.

Morus alba L. White Mulberry. Glen Cove.—Jelliffe.

Morus rubra (..) Red Mulberry. Davenport estate, C.S.H.—N.M.G.

Papyrius papyrifera (L) Kuntze. Paper Mulberry. Fish Hatchery, C.S.H.—N.M.G.

CANNABINACEAE.

Cannabis sativa L. Hemp. C.S.H. vicinity.—G.H.H.

Humulus Lupulus L. Hop. C.S.H. vicinity.—N.M.G.

URTICACEAE.

Boehmeria cylindrica (L) Sw. False Nettle. C.S.H. vicinity.—N.M.G.

Pilea pumila (L) A. Gray. Clear weed. C.S.H. village near water and on sidewalks.—G.H.H.

Urtica dioica L. Stinging Nettle. C.S.H. vicinity.—N.M.G.

Urtica gracilis Ait. Slender Nettle. C.S.H. vicinity.—N.M.G.

Urticastrum divaricatum (L) Kuntze. Wood Nettle.—Jelliffe.

SANTALACEAE.

Comandra umbellata (L) Bastard Toad-flax. Hempstead Plain, Hicksville.—N.M.G.

ARISTOLOCHIACEAE.

Aristolochia macrophylla Lam. Dutchman's Pipe. On barn near Carnegie buildings, C.S.H.—N.M.G.

Aristolochia Serpentaria L. Virginia Snakeroot. Glen Cove.—Jelliffe.

Asarum canadense L. Indian Ginger. Havemeyer Estate, C.S.H. vicinity.—N.M.G.

Hexastylis virginica (L) Small. Virginia Hexastylis. Havemeyer Estate, C.S.H. vicinity.—G.H.H.

POLYGONACEAE.

Fagopyrum Fagopyrum (L) Karst. Buckwheat. C.S.H. vicinity.—Jelliffe.

Persicaria amphibia (L) S. F. Gray. Water Persicaria, Oyster Bay, C.S.H. vicinity.—Jelliffe.

Persicaria Carey (Olney) Green. Carey's Persicaria. Swamp near L. Ronkonkema.—N.M.G.

Persicaria hydropiper L. (Opiz) Water Pepper. C.S.H. vicinity.—J.A.H.

Persicaria hydropiperoides Mchx. Mild Water Pepper. C.S.H. vicinity—Jelliffe.

Persicaria lapathifolia (L) S. F. Gray. Dock-leaved Persicaria. West Shore, C.S.H.—Jelliffe.

Persicaria orientalis (L) Spach. Prince's Feather. Roadsides, C.S.H.—N.M.G.

Persicaria pennsylvanica. Small. Pennsylvania Persicaria. Near R. R. depot, C.S.H.—G.H.H.

Persicaria Persicaria L. Lady's Thumb. C.S.H., Moist ground.—N.M.G.

Persicaria punctata (Ell.) Small. Water Smart Weed. Damp soil near Eugenics Record Office.—C.E.

Persicaria punctata var. *leptostachyum* Meisn. Water Smartweed. C.S.H., Lake marsh.—N.M.G.

Pleuropterus Zuccarinii Small. Japanese Knotweed. C.S.H. vicinity.—Jelliffe.

Polygonella articulatum L. Coast Jointweed. C.S.H. vicinity. —N.M.G.

Polygonum arifolium L. Halberd-leaved Tear-thumb. C.S.H., 1st lake shore.—N.M.G.

Polygonum aviculare L. Knotgrass. Waste places, vicinity C.S.H.—N.M.G.

Polygonum erectum L. Erect Knotweed. C.S.H. vicinity.—J.A.H.

Polygonum maritimum L. Seaside Knotweed. Salt Marsh, C. S.H.—H.S.C.

Polygonum tenue Michx. Slender Knotweed. Oyster Bay, C.S.H. vicinity.—Jelliffe.

Rumex acetosella L. Sheep Sorrell. Fields, C.S.H.—N.M.G.

Rumex Brittainca L. Great Water-Dock. Swamp, C.S.H.—G.H.H.

Rumex crispua L. Curled Dock. Roadsides, C.S.H.—N.M.G.

Rumex obtusifolius L. Bitter Dock. Roadsides, C.S.H.—N. M.G.

Tiniaria Convolvulus. (L) Webb and Mog. Black Bind Weed. C.S.H. vicinity.—J.A.H.

Tovara virginiana. Raf. Virginia Knotweed. Jones Marsh, C.S.H.—C.E.

Tracaulon sagittatum (L) Small. Arrow-leaved Tear-thumb. Salt Marsh and Jones Woods, C.S.H.—C.E.

AMARANTHACEAE.

Amaranthus graecizans L. Tumbleweed. Common. C.S.H.—G.H.H.

Amaranthus pumilis Raf. Coast Amaranth.—Jelliffe.

Amaranthus retroflexus L. Green Amaranth. Common, C. S.H.—N.M.G.

CHENOPODIACEAE.

Atriplex arenaria Nutt. Sea-beach Atriplex. Sand Spit, C. S.H.—N.M.G.

Atriplex hastata L. Halberd-leaved Orache. Salt Marsh, C. S.H.—N.M.G.

Chenopodium album L. Lamb's Quarters. Roadsides, C.S. H.—N.M.G.

Chenopodium ambrosioides L. Mexican Tea. Dump, Carnegie Inst., C.S.H.—N.M.G.

Chenopodium Bonus-Henricus L. Good King Henry. Glen Cove.—Jelliffe.

Chenopodium boscianum Moq. Bosc's Goose-foot. C.S.H. vicinity.—G.H.H.

Chenopodium urbicum L. Upright Goosefoot. Oyster Bay.—Jelliffe.

Chenopodum murale L. Nettle-leaved Goosefoot. Oyster Bay. —Jelliffe.

Dondia linearis (Ell.) Heller. Tall Sea-Blite.—N.M.G.

Dondia maritima L. Druce, Low Sea-Blite. Salt Marsh, C. S.H.—N.M.G.

Roubieva multifida (L) Moq. Cut-leaved Goosefoot. C.S.H. —N.M.G.

Salicornia ambigua Michx. Woody Glasswort. Salt Marshes, C.S.H.—N.M.G.

Salicornia Bigelovii Torn. Bigelow's Glasswort. Sand Spit, C.S.H.—Jelliffe.

Salicornia europea L. Jointed Glasswort. Salt marsh, C.S. H.—N.M.G.

Salsola Kali. L. Saltwort. Sandy beaches,C.S.H.—N.M.G.

PHYTOLACCACEAE.

Phytolacca Americana L. Poke. Common. C.S.H. vicinity. —N.M.G.

CORRIGIOLACEAE.

Anychia canadensis (L) B.S.P. Slender Forked Chickweed. C.S.H., Oyster Bay.—Jelliffe.

AIZOACEAE.

Mollugo verticillata L. Carpet-weed. Sandspit, C.S.H.; Matheson's Estate, Lloyd Neck, L. I.—N.M.G.

Sesuvium maritimum (Walt.) B.S.P. Sea Purslane. C.S.H. —N.M.G.

PORTULACACEAE.

Claytonia virginica L. Spring Beauty. C.S.H. vicinity. — J.B.W.

Portulaca grandiflora Lindl. Garden Portulaca. Cultivated, C.S.H. vicinity.—N.M.G.

Portulaca oleracea L. Purslane. Fields and waste places, C. S.H.—N.M.G.

Portulaca pilosa L. Hairy Portulaca. Gilgo Beach, L. I.— N.M.G.

ALSINACEAE.

Cerastium viscosum L. Mouse-ear Chickweed.—Jelliffe.

Moehringia laterifolia (L) Fenzl. Blunt-leaved Sandwort.— Jelliffe.

CARYOPHYLLACEAE.

Agrostemma Githago (L) Lam. Corn Cockle. Barnyard, C. S.H.—G.H.H.

Alsine borealis Bigel. Northern Stitchwort. C.S.H., shaded and wet places.—N.M.G.

Alsine longifolia Muhl. Long-leaved Stitchwort. Roadsides, C.S.H.—G.H.H.

Alsine media L. Common Chickweed, C.S.H. vicinity—G.H.H.

Arenaria serpyllifolia L. Thyme-leaved Sandwort. C.S.H. vicinity.—J.A.H.

Cerastium arvense L. Field Chickweed. C.S.H.—N.M.G.

Cerastium semidecandrum L. Small Chickweed. C.S.H. vicinity.—N.M.G.

Dianthus armeria L. Deptford Pink. C.S.H. vicinity, in fields.—N.M.G.

Honkenya peploides (L) Ehrb. Sea-beach Sandwort. Gilgo Beach, L.I.—N.M.G.

Lychnis alba M. White Campion. Roadsides, C.S.H.—N. M.G.

Lychnis coronaria L. Mullein Pink. Hicksville.—N.M.G.

Lychnis dioica L. Red Campion. Waste Ground, roadsides, C.S.H.—N.M.G.

Sagina procumbens. L. Procumbent Pearlwort. Jones Marsh, C.S.H.—C.E.

Saponaria officinalis L. Bouncing Bet. Bayville, L. I.; roadsides, C.S.H.—N.M.G.

Scleranthus annuus L. German Knotgrass. Vicinity Biological Lab., C.S.H.—G.H.H.

Silene antirrhina L. Sleepy Catchfly.—Jelliffe.

Silene carolinana Walt. Wild Pink. Vicinity C.S.H.—J.A.H.

Silene latifolia Mill. Bladder Campion. C.S.H. vicinity.—N. M.G.

Silene noctiflora L. Night-flowering Catchfly. C.S.H., Oyster Bay.—Jelliffe.

Silene stellata L. Starry Campion. Woods near roadside, C. S.H.—N.M.G.

Tissa marina L. (Britton) Salt-marsh Sand Spurry. Brackish sands, C.S.H. vicinity.—N.M.G.

CERATOPHYLLACEAE.

Ceratophyllum demursum L. Horn Weed. Lakes, C.S.H.—N. M.G.

NELUMBONACEAE.

Nelumbo lutea (Willd.) Pers. American Lotus.—Jelliffe.

NYMPHAEACEAE.

Brasenia schreberi Gmel. Water Shield. 1st lake, C.S.H.; Spectacle Pond, St. James, L.I.—N.M.G.

Castalia odorata (Cut.) Sweetscented Water Lily. 1st lake, C.S.H.—N.M.G.

Nymphaea advena Ait. Large Yellow Pond Lily. Spectacle pond, St. James, L. I.—N.M.G.

MAGNOLIACEAE.

Liriodendron Tulipifera L. Tulip tree. C.S.H. vicinity.—N. M.G.

RANUNCULACEAE.

Actaea alba (L) Milli. White Baneberry. Woods near 1st lake, C.S.H.—N.M.G.

Anemone quinquefolia L. Wind-flower. Vicinity C.S.H.—N. M.G.

Anemone virginiana L. Tall Anemone. Woods, C.S.H.—J. H.H.

Aquilegia canadensis... L. Wild Columbine. Woods, C.S.H. —J.H.H.

Caltha palustris L. Marsh Marigold. Vicinity C.S.H.—N. M.G.

Cimicifuga racemosa (L) Nutt. Black Snakeroot. Hodenpyl Estate, Locust Valley, L. I.—N.M.G.

Clematis virginiana L. Virginia Virgin's Bower. Fish Hatchery, C.S.H.—N.M.G.

Helleborus viridis L. Green Hellebore. Glen Cove.—N.M.G.

Hepatica acutiloba, D. C. Sharp-lobed Liverwort. Havemeyer Estate, near Oyster Bay, L. I.—N.M.G.

Hepatica hepatica (L) Karst. Round-lobed Liverwort. Havemeyer Estate.—N.M.G.

Ranunculus abortivus L. Kidney-leaved Crowfoot. C.S.H. vicinity.—N.M.G.

Ranunculus acris L. Tall Buttercup. C.S.H. vicinity.—N. M.G.

Ranunculus bulbosus L. Bulbous Buttercup. C.S.H. vicinity. —G.H.H.

Ranunculus recurvatus. Poir. Rough Crowfoot. C.S.H. vicinity.—N.M.G.

Ranunculus repens L. Creeping Buttercup. Along ditches, C.S.H.—N.M.G.

Ranunculus scleratus L. Celery-leaved Crowfoot. Oyster Bay.—Jelliffe.

Ranunculus septentrionalis Poir. Marsh Buttercup, C.S.H. vicinity.—N.M.G.

Syndesmon thalictroides (L) Hoffmg. Rue Anemone. Common throughout island.—Jelliffe.

Thalictrum dioicum L. Early Meadow-Rue. C.S.H. vicinity. —N.M.G.

Thalictrum polygamum Muhl. Fall Meadow Rue. Common throughout island.—Jelliffe.

Thalictrum revolutum L. Waxy Meadow-Rue. Hempstead Plains, Hicksville, L. I.—N.M.G.

BERBERIDACEAE.

Berberis vulgaris L. European Barberry. De Forest Estate; Carnegie Inst., C.S.H.—N.M.G.

MENISPERMACEAE.

Menispermum canadense L. Canada Moonseed. Road to Sandspit, C.S.H.—N.M.G.

LAURACEAE.

Benzoin aestivale (L) Nees. Spice Bush. Roadsides, C.S.H. —N.M.G.

Sassafras Sassafras (L) Karst. Sassafras Tree. Roadsides, Woods, C.S.H.—N.M.G.

PAPAVERACEAE.

Chelidonium majus L. Celandine, C.S.H., roadsides.—N.M.G.

Macleya cordata (Willd.) R. Br. Plume Poppy. Lloyd's Point, L.I. Escaped from cultivation.—N.M.G.

Papaver dubium L. Long Smooth-fruited Poppy. Oyster Bay, Fields.—Jelliffe.

Sanguinarea canadensis L. Boloroot. C.S.H. vicinity—N. M.G.

FUMARIACEAE.

Fumaria officinalis L. Fumitory. C.S.H. vicinity.—N.M.G.

CRUCIFERAE.

Alliaria alliaria (L) Britton. Hedge Garlic. Vicinity Biological Lab., C.S.H.—G.H.H.

Arabis lyrata L. Lyre-leaved Rock-cress. Vicinity C.S.H.— G.H.H.

Armoracia Armoracia (L) Britton. Horse-radish. Vicinity C.S.H.—N.M.G.

Barbarea Barbarea (L) MacM. Yellow Rocket.—G.H.H.

Barbarea stricta (Andre) Marsh. Erect-fruited Winter-cress. C.S.H.—Jelliffe.

Barbarea verna (Mill.) Aschers. Land Cress. Roadsides at Salt Marsh, C.S.H.—G.H.H.

Brassica campestris L. var. *napus*. Turnip. Roadsides, C. S.H.—N.M.G.

Brassica nigra (L) Koch. Black Mustard. Waste places, C.S.H.—N.M.G.

Brassica oleracea L. Cabbage. Cultivated, C.S.H.—N.M.G.

Bursa bursa-pastoris (L) Britton. Shepherd's purse. Waste ground, C.S.H.—G.H.H.

Cakile edentula (Bigel.) Hook. American Sea Rocket. Sand of upper beach, C.S.H.—N.M.G.

Carara didyma (L) Britton. Lesser Wart-cress. Vicinity C.S.H.—G.H.H.

Cardamine hirsuta L. Hairy Bitter-cress. Oyster Bay, C.S.H.—N.M.G.

Cardamine pennsylvanicum Muhl. Pennsylvania Bitter-cress. C.S.H.—N.M.G.

Diplotaxis muralis (L) D.C. Sand Rocket. Roadsides, C.S.H.—N.M.G.

Erysimum officinale L. Hidge Mustard. Waste places, C.S.H.—N.M.G.

Hesperis matronalis L. Dame's Rocket. Vicinity, C.S.H.—G.H.H.

Lepidium campestre L. Field Cress. Vicinity C.S.H.—N.M.G.

Lepidium virginicum L. Wild Pepper-grass Vicinity C.S.H.——N.M.G.

Norta altissima (L) Britton. Tall Sisymbrium. Waste places, C.S.H.—N.M.G.

Radicula sylvestris L. Druce. Roadside near depot, C.S.H.—G.H.H.

Raphanus sativus L. Garden Radish. Cultivation C.S.H.—G.H.H.

Sinapis alba L. Escaped. White mustard.—Jelliffe.

Sisymbrium Nasturtium—aquaticum (L) True water-cress. Old fish runway, C.S.H.—N.M.G.

Thlaspi arvense L. Field Penny-cress. Waste places, C.S.H.—G.H.H.

SARRACENIACEAE.

Sarracenia purpurea L. Pitcher Plant. Hodenpyl Estate, Locust Valley, N. Y.—N.M.G.

DROSERACEAE.

Drosera filiformis Raf. Thread-leaved Sundew. C.S.H.—N. M.G.

Drosera intermedia Hayne. Spatulate-leaved Sundew. Pine Barren Bogs; Shores L. Ronkonkema, L. I.—N.M.G.

Drosera longifolia L. Oblong-leaved Sundew. L. Ronkonkema, L. I.—N.M.G.

Drosera rotundifolia L. Round-leaved Sundew. C.S.H., between 2nd and 3d lakes.—N.M.G.

CRASSULACEAE.

Penthorum sedoides L. Ditch Stonecrop. Woodbury, L. I.—N.M.G.

Sedum acre. L. Wall-pepper. DeForest Cemetery, C.S.H.—N.M.G.

Sedum Telephium L. Orpine. Roadsides, C.S.H.—N.M.G.

Sedum ternatum Mx. Wild Stonecrop. C.S.H. village, roadside.—G.H.H.

SAXIFRAGACEAE.

Chrysoplenium americanum. L. Golden Saxifrage. Creek between 1st and 2nd lakes, C.S.H.—N.M.G.

Heuchera americana L. Alum-root. Oyster Bay.—Jelliffe.

Micranthes pennsylvanica (L) Haw. Swamp Saxifrage. Glen Cove.—Jelliffe.

Micranthes virginiensis (Mx.) Early Saxifrage. Vicinity, C. S.H.—N.M.G.

HAMAMELIDACEAE.

Hamamelis virginiana L. Witch-Hazel, C.S.H. vicinity.—N. M.G.

Liquidamber Styraciflua L. Sweet Gum. Cultivated. C.S.H. vicinity.—N.M.G.

GROSSULARIACEAE.

Ribes americanum Mill. Wild Black Currant. C.S.H.—N. M.G.

Ribes nigrum L. Black Currant. Escaped, C.S.H.—N.M.G.

Ribes triste. Pall. American Red Currant. C.S.H.—N.M.G.

PLATANACEAE.

Platanus occidentalis L. Plane Tree. C.S.H. vicinity.—N. M.G.

ROSACEAE.

Agrimonia gryposephala. Wallr. Tall Hairy Agrimony. Jones Marsh, C.S.H.—C.E.

Agrimonia parviflora. Soland. Many-flowered Agrimony. C.S.H.—Jelliffe.

Agrimonia rostellata Wallr. Woodland Agrimony.—Jelliffe.

Duchesnea indica. Andr. Mock Strawberry. Roadsides, C. S.H.—N.M.G.

Filipendule rubra (Hill.) Robinson. Queen-of-the-Prairie. Escaped from cultivation, Lloyd's Point.—N.M.G.

Fragaria vesca L. Hedge Strawberry. Vicinity C.S.H.—J. A.H.

Fragaria virginiana Duchesne. Virginia Strawberry. Roadsides, C.S.H.—N.M.G.

Geum canadense. Jacq. White Avens. Moist woods, C.S.H.—N.M.G.

Geum virginianum L. Rough Avens. Roadsides, C.S.H.—N.M.G.

Potentilla argentea L. Silvery Cinquefoil. Roadsides, C.S.H. —G.H.H.

Potentilla canadensis L. Five-finger. Hempstead Plains, St. James, L. I., Pine Barrens.—N.M.G.

Potentilla intermedia L. Downy Cinquefoil. Waste places, roadsides, C.S.H.—N.M.G.

Potentilla montspeliensis L. Rough Cinquefoil. Road to Sand spit, C.S.H.—J.A.H.

Potentilla montspeliensis var. *norvegica Rybd.* Vicinity C. S.H.—J.A.H.

Potentilla Robbinsiana. Oakes. Robbins' Cinquefoil, C.S.H. vicinity.—J.A.H.

Rosa carolina L. Wild Rose. Woodbury Bog, Woodbury, L. I.—N.M.G.

Rosa rubiginosa L. Sweetbrier. Jones Marsh, C.S.H.—C.E.

Rubus alleghaniensis. Porter. Mountain Blackberry. Roadside, Salt Marsh, C.S.H.—H.S.C.

Rubus baileyanus. Britton. Bailey's Blackberry. C.S.H.—G.H.H.

Rubus canadensis Linn. Millspaugh's Blackberry. Jones' woods, C.S.H.—N.M.G.

Rubus hispidus L. Running Swamp Blackberry. Vicinity C.S.H.—N.M.G.

Rubus neglectus. Peck. Purple Wild Raspberry. Huntington Hill road, C.S.H.—N.M.G.

Rubus occidentalis L. Black Raspberry. Vicinity C.S.H.—J.A.H.

Rubus odoratus L. Thimbleberry. C.S.H.—N.M.G.

Rubus phoeniculasius. Maxim. Wineberry. Escaped from cultivation, C.S.H.—N.M.G.

Rubus procumbens Muhl. Dewberry. Roadsides, C.S.H.—N.M.G.

Rubus strigosus Mchx. Wild Red Raspberry. Vicinity C.S.H.—J.A.H.

Sanguisorba canadensis L. American Great Burnet. Common throughout island.—Jelliffe.

Schizonotus sorbifolius L. Sorb-leaved Schizonotus. Vicinity C.S.H.—N.M.G.

Sibbaldiopsis tridentata (Solona) Rydb. Three-toothed Cinquefoil. Hodenpyl estate, Locust Valley, L. I.—N.M.G.

Spiraea latifolia Borkh. American Meadow-Sweet. Roadsides, C.S.H.—N.M.G.

Spiraea tomentosa L. Hardhack. L. Ronkonkema, L. I. —N.M.G.

MALACEAE.

Amelanchier canadensis. Medic. Service Berry. C.S.H.—N.M.G.

Amelanchier spicata. Chowl D. C. Low June Berry. C.S.H —N.M.G.

Aronia arbutifolia Pers. Red Choke-berry. Vicinity C.S.H. —N.M.G.

Aronia atropurpurea Britton. Purple-fruited Choke-berry. Pine barrens, L.I.—N.M.G.

Aronia melanocarpa (Mischx) Britton. Black Choke-berry. C.S.H.—N.M.G.

Crataegus Oxyacantha Linn. English Hawthorne. Davenport property, C.S.H.—N.M.G.

Malus malus (L) Britton. Apple. Vicinity C.S.H.—N.M.G.

Pyrus communis L. Choke Pear. Cultivated. C.S.H.—N.M.G.

Sorbus americana Dum Cours. American Mountain Ash. Cultivated C.S.H.—N.M.G.

Sorbus Aucuparia. L. European Mountain Ash. C.S.H.—N.M.G.

AMYGDALACEAE.

Prunus Avium L. Crab Cherry. Road near 1st lake C.S.H. —N.M.G.

Prunus Cerasus L. Sour Cherry. Vicinity C.S.H.—N.M.G.

Prunus maritima Wong. Beach Plum. Bayville, L.I., Sand dunes.—N.M.G.

CAESALPINACEAE.

Cassia marilandica. L. Wild Senna. Oyster Bay.—Jelliffe.

Chamaecrista fasciculata (Michx.) Greene Prairie Pea. C.S. H.—N.M.G.

Chamaecrista nictitans (L) Moench. Sensitive Pea. In fields C.S.H.—N.M.G.

Gleditsia triacanthos L. Black Locust. C.S.H.—N.M.G.

FABACEAE.

Amorpha fructicosa. L. False Indigo. Dayenport Estate, C. S.H.—N.M.G.

Baptisia tinctoria L. R. Bc. Wild Indigo. Vicinity 3rd Lake, C.S.H.; Hempstead Plain.—N.M.G.

Cracca virginiana L. Goat's Rue. Vicinity C.S.H.—N.M.G.

Falcata comosa. Kuntze. Hog Pea-nut. Jones woods near first lake.—G.H.H.

Glycine sp? Jones' woods, Vicinity C.S.H.—G.H.H.

Lathyrus latifolius L. Everlasting Pea. In gardens, escaping to thickets, C.S.H.—N.M.G.

Lathyrus maritimus (L) Bigel. Beach Pea. Beaches, C.S.H. and vicinity—N.M.G.

Lespedeza capitata Michx. Round-headed Bush-clover. R.R. west of depot, C.S.H.—G.H.H.

Lespedeza frutescens. Britton. Wand-like Bush-clover. R.R. west of Depot, C.S.H.—G.H.H.

Lespedeza hirta L. Hariy Bush-Clover. Pine Barrens near St. James, L. I.—N.M.G.

Lespedeza repens. Creeping Brush-Clover. R.R. west of Depot, C.S.H.—N.M.G.

Lespedeza cirginica L. Slender Bush-Clover. R.R. west of depot, C.S.H.—N.M.G.

Lupinus perennis L. Wild Lupine. Syosset,—H.S.C.
Medicago lupulina L. Hop Clover. C.S.H.—J.A.H.
Medicago sativa L. Alfalfa. C.S.H.—N.M.G.
Meibomia canescens Kuntze. Hoary Tick-Trefoil. Near Syosset.—H.S.C.
Meibomia grandiflora (Walt.) Kuntze. Pointed-leaved Tick-Trefoil.—N.M.G.
Meibomia marilandica (L) Kuntze. Smooth Small-leaved Tick-Trefoil. Oyster Bay.—N.M.G.
Meibomia Michauxii. Vail. Prostrate Tick-Trefoil. R.R. west of depot, C.S.H.—G.H.H.
Meibomia nudiflora (L) Kuntze. Naked-flowered Tick-Trefoil. Woods near Eugenics Record Office.—N.M.G.
Meibomia paniculata (L) Kuntze. Panicled Tick-Trefoil. Oyster Bay.—N.M.G.
Meibomia rigida Kuntze. Rigid Tick-Trefoil. C.S.H. vicinity.—N.M.G.
Melilotus alba. Desr. White Melilot. Roadside, C.S.H. —N.M.G.
Melilotus officinalis Lam. Yellow Melilot. C.S.H., in fields. —N.M.G.
Robinia pseudoacacia L. Locust-tree. Vicinity C.S.H.—N.M.G.
Strophostyles helvola (L) Britton. Trailing Wild Bean. Sand spit, C.S.H.—N.M.G.
Stylosanthes biflora (L) B.S.P. Pencil Flower. Syosset.—H.S.C.
Trifolium agrarium L. Yellow Hop-Clover. C.S.H., sandy fields, roadsides.—N.M.G.
Trifolium arvense L. Rabbit-foot. Gravelly soil, roadsides, C.S.H.—N.M.G.
Trifolium hybridum L. Alsatian Clover. Fields and roadsides, C.S.H.—N.M.G.
Trifolium pratense L. Red Clover. Roadsides and fields, C.S.H.—N.M.G.
Trifolium procumbens L. Low Hop-Trefoil. Vicinity, C.S.H. —N.M.G.
Trifolium repens L. White Clover. Roadsides, Lawns, C.S.H. —N.M.G.
Vicia Cracca L. Cow Vetch. In fields, C.S.H.—N.M.G.

Vicia tetrasperma L. Slender Vetch. Roadsides, C.S.H.—G. H.H.

Wisteria chinensis Sweet Wisteria. Escaped, cultivated, C.S. H.—N.M.G.

GERANIACEAE.

Geranium Bicknellii Britton. Bicknell's Crane's-bill. C.S.H.—N.M.G.

Geranium maculatum L. Spotted Crane's-bill. Woods, C.S. H., Hempstead Plain,—N.M.G.

Geranium pusillum Burm. Small flowered Crane's-bill. Vicinity C.S.H.—N.M.G.

OXALIDACEAE.

Xanthoxalis grandis. Small. Great Yellow Wood-sorrel. C. S.H.—N.M.G.

Xanthoxalis corniculata (L) Small. Yellow Procumbent Wood-sorrel. Vicinity C.S.H.—N.M.G.

Xanthoxalis stricta (L) Small. Upright Yellow Wood-sorrel. Roadsides, C.S.H.—G.H.H.

LINACEAE.

Cathartolinum floridanum (Planch) Small. Florida Yellow Flax—Jelliffe.

Cathartolinum medium (Planch) Small. Stiff Yellow Flax. Jones Marsh, C.S.H.—C.E.

Linum usitatissimum. Flax. Pine Barrens, L. I.—G.H.H.

Millegrana Radiola (L) All-seed. Vicinity C.S.H.—G.H.H.

BALSAMINACEAE.

Impatiens balsamina Linn. Touch-me-not. Jones Marsh, C. S.H.—N.M.G.

Impatiens biflora. Walt. Spotted Touch-me-not. C.S.H. Moist woods.—N.M.G.

Impatiens noli-tangere L. Jones Marsh, C.S.H.—N.M.G.

RUTACEAE.

Ptelea trifoliata L. Three-leaved Hop-tree, C.S.H. village.—N.M.G.

Zanthoxylum americanum Mill. Prickley Ash. Oyster Bay, Glen Cove.—Jelliffe.

SIMAROUBACEAE.

Ailanthus glandulosa Desf. Ailanthus. Vicinity C.S.H. — N.M.G.

POLYGALACEAE.

Polygala Nuttalli F. and G. Nuttall's Milkwort. Vicinity C.S. H.—N.M.G.

Polygala polygama Walt. Racemed Milkwort. Hempstead Plains, L. I.—N.M.G.

Polygala verticillata L. Whorled Milkwort. Vicinity C.S.H. —N.M.G.

Polygala viridescens L. Purple Milkwort. Hempstead Plain, Hicksville, L. I.—N.M.G.

EUPHOBRIACEAE.

Acalypha virginica L. Mercury-weed. Vicniity C.S.H.—N. M.G.

Chamaesyce humistrata, (Engelm.) Small. Hairy Spreading Spurge. Common.—N.M.G.

Chamaesyce maculata L. Small. Milk Purslane. R.R., west of Depot C.S.H.—G.H.H.

Chamaesyce polygonifolia (L) Small. Seaside Spurge. Upper Beach, C.S.H.—N.M.G.

Ricinus communis L. Castor Bean.—N.M.G.

Tithymalopsis corollata (L) Kl. and Garcke. Flowering Spurge. Matheson Estate, Lloyd's Neck.—N.M.G.

Tithymalopsis Ipecacuanhae (L) Small. Wild Ipecac. Vicinity C.S.H.—G.H.H.

Tithymalus Cyaprissias (L) Hill. Cypress Spurge.—N.M.G

CALLITRICHACEAE.

Callitriche heterophylla Pursh. Larger Water-Starwort. C. S.H. vicinity.—N.M.G.

BUXACEAE.

Pachysandra procumbens Mchx. Alleghany Mountain Spurge. Hicks Nursery, Westbury, L. I.—N.M.G.

ANACARDIACEAE.

Rhus copallina L. Dwarf Black Sumac. C.S.H.; Hempstead Plains, L. I.—N.M.G.

Rhus glabra L. Scarlet Sumac, C.S.H.—N.M.G.

Rhus hirta L. Staghorn Sumac. C.S.H.—N.M.G.

Toxicodendron radicans (L) Kuntze. Poison Ivy. Common. —N.M.G.

Toxicodendron vernix (L) Kuntze. Poison Sumac. Between 1st and 2nd lakes, Bunker Swamp.—N.M.G.

ILICACEAE.

Ilex laevigata (Pursh) A. Gray. Gray Smooth Winterberry. Oyster Bay.—Jelliffe.

Ilex opaca Ait. American Holly. Vicinity C.S.H.—N.M.G.

Ilex verticillata (L) Gray. Virginia Winterberry. Low thicket, Jones Marsh, C.S.H.—N.M.G.

CELASTRACEAE.

Celastrus scandens L. Climbing Bittersweet. Huntington Hill roadside, C.S.H.—N.M.G.

Evonymus atropurpureus Jacq. Burning Bush. Cultivated. Hick's Nursery, Westburg, L. I.—N.M.G.

Evonymus radicans Sieb. Roadside, near De Forest Estate, C.S.H.—N.M.G.

STAPHYLEACEAE.

Staphylea trifolia L. American Bladder nut. Cultivated, C. S.H.—N.M.G.

ACERACEAE.

Acer Negundo L. Box Elder, C.S.H.—N.M.G.

Acer pennsylvanicum L. Striped Maple. Near Cold Spring Harbor Village.—N.M.G.

Acer platanoides L. Norway Maple. Roads and lawns, C.S. H.—N.M.G.

Acer Pseudo-Platanus L. Sycamore Maple. Matheson Estate, Lloyd Neck, L. I.—N.M.G.

Acer rubrum L. Red Maple. Woods, C.S.H.—N.M.G.

Acer saccharinum L. Silver Maple. Matheson Estate—N. M.G.

Acer saccharum Marsh. Sugar Maple. C.S.H. vicinity.—N. M.G.

AESCULACEAE.

Aesculus Hippocastaneum L. Horse-Chestnut. Jones Estate, C.S.H.—N.M.G.

RHAMNACEAE.

Ceanothus americanus L. New Jersey Tea. Hempstead Plains, Hicksville, L. I.—N.M.G.

Rhamnus cathartica L. Buckthorn. Vicinity C.S.H.—G.H.H.

VITACEAE.

Parthenocissus quinquefolia Planch. Virginia Creeper. Common. C.S.H.—N.M.G.

Vitis aestivalis Mx. Summer Grape. Woods, C.S.H.—N.M.G.

Vitis bicolor (Le Conte) Blue Grape. Jones Woods, C.S.H.—N.M.G.

Vitis cordifolia Mchx. Frost Grape. Vicinity C.S.H.—G.H.H.

Vitis Labrusca L. Northern Fox-grape. Roadsides, C.S.H.—N.M.G.

TILIACEAE.

Tilia americana L. American Linden. Davenport Lawn, C.S.H.—N.M.G.

Tilia pubescens Ait. Southern Bass-wood. Common throughout island.—Jelliffe.

MALVACEAE.

Abutilon Abutilon Rusky. Velvet leaf. Vicinity C.S.H. —G.H.H.

Althaea officinalis L. Marsh-Mallow. Oyster Bay.—Jelliffe.

Callirhoe involucrata (T. and G.) Gray. Purple Poppy-Mallow. Hicks Nursery, Westbury, L. I.—N.M.G.

Hibiscus esculentus L. Laughlin garden, C.S.H.—G.H.H.

Hibiscus moscheutos L. Swamp Rose-Mallow. Fresh water marsh, C.S.H.—N.M.G.

Hibiscus oculiroseus Britton. Crimson-eye Rose-Mallow. Fresh water marsh, C.S.H.—N.M.G.

Hibiscus Syriacus. L. Rose-of-Sharon. Eugenics Record Office, C.S.H.—N.M.G.

Malva Alcea L. European Mallow. C.S.H. village.—G.H.H.

Malva moschata L. Musk Mallow. C.S.H.—Jelliffe.

Malva rotundifolia L. Dwarf Mallow. Roadsides, C.S.H.—N.M.G.

HYPERICACEAE.

Ascyrum hypericoides L. St. Andrew's Cross.—N.M.G.

Hypericum adpressum Bart. Creeping St. John's-wort. Lloyd's Point, L. I.—G.H.H.

Hypericum canadense L. Canadian St. John's-wort. Salt Marsh, C.S.H.—H.S.C.

Hypericum mutilum L. Dwarf St. John's-wort. Davenport Farm, C.S.H.—N.M.G.

Hypericum perforatum L. Common St. John's-wort. Fields, C.S.H.—N.M.G.

Hypericum punctatum (Lam) Spotted St. John's-wort. C.S.H.—N.M.G.

Sarothra gentianoides L. Orange-grass. C.S.H. Hempstead Plain, Hicksville, L. I.—N.M.G.

Triadenum virginicum (L) Raf. Marsh St. John's-wort. Fresh water swamp, C.S.H.—J.A.H.

CISTACEAE.

Crocanthemum canadense (L) Britton. Rock-rose. C.S.H.—N.M.G.

Crocanthemum majus (L) Britton. Hoary Frostweed. Hempstead Plain, Hicksville, L. I.—N.M.G.

Hudsonia tomentosa Nutt. False Heather. Bayville, L. I.—N.M.G.

Lechea intermedia Leggett. Large-podded Pinweed. Syosset, L. I.—H.S.C.

Lechea maritima Leggett. Beach Pinweed. Oyster Bay.—Jelliffe.

Lechea minor L. Thyme-leaved Pinweed. Oyster Bay.—Jelliffe.

Lechea villosa Ell. Large Pinweed. Hempstead Plain, Pine Barren region, L. I.—N.M.G.

VIOLACEAE.

Viola arvensis Murr. European Field Pansy. Near Laboratory, C.S.H.—N.M.G.

Viola blanda Willd. Sweet White Violet. C.S.H.—J.A.H.

Viola fimbriatula Sm. Ovate-leaved Violet.—G.H.H.

Viola incognita (var. *Forbesii*) Brainerd. Large-leaved White Violet. C.S.H.—N.M.G.

Viola lanceolata L. Water Violet. Common throughout island.—Jelliffe.

Viola labradorica Schrank. Alpine Violet. Vicinity C.S.H. J.A.H.

Viola odorata L. Sweet Violet. Vicinity C.S.H.—J.A.H.

Viola palmata L. Early Blue Violet. C.S.H.—N.M.G.

Viola pallens (Banks) Brainerd. Northern White Violet. C.S.H.—N.M.G.

Viola papilionacea domestica (Bisk) Coll. Hooded Blue Violet. —J.A.H.

Viola pedata L. Bird's-foot Violet. Hempstead Plains, Hicksville, L. I.—N.M.G.

Viola primulifolia L. (Harper) Primrose-leaved Violet. Common throughout island.—N.M.G.

Viola pubescens Ait. Downy Yellow Violet. Common throughout island.—N.M.G.

Viola sagittata L. Arrow-leaved Violet. West Hills, Huntington, L. I.—B. Watt.

Viola scabriuscula Schwein. Smooth Yellow Violet. Vicinity C.S.H.—J.A.H.

Viola sororia Willd. Woolly Blue Violet. Vicinity C.S.H.—G.H.H.

Viola tricolor L. Pansy. Common throughout island.—Jelliffe.

CACTACEAE.

Opuntia Opuntia (L) Coult. Eastern Prickly Pear. C.S.H. vicinity.—N.M.G.

ELEAGNACEAE.

Eleagnus argentea Pursh. Silver-berry. Jones farm; Hodenpyl Estate, Locust Calley, L. I.—N.M.G.

LYTHRACEAE.

Decodon verticillata (L) Ell. Swamp Loosestrife. Pine Barrens; Swamps, L. I.—N.M.G.

Lythrum Salicaria L. Spiked Loosestrife. Matheson Estate, Lloyd Neck, L. I.—N.M.G.

MELASTOMACEAE.

Rhexia virginica. Meadow-Beauty. Kettle Hole Bog, Woodbury, L. I.—H.S.C.

ONAGRACEAE.

Chamaenerion angustifolium (L) Scop. Fire-Weed. Pine Barrens, Hempstead Plain.—N.M.G.

Circaea lutetiana L. Enchanter's Nightshade. Woods, C.S.H.—N.M.G.

Epilobium coloratum, Muhl. Purple-leaved Willow-herb. Dying Pond vicinity, C.S.H.—N.M.G.

Isnardia palustris L. Marsh Purslane. Muddy ditches, swamps, C.S.H.—J.A.H.

Kneiffia fructicosa (L) Raimann. Common Sundrops. C.S.H. vicinity.—N.M.G.

Kneiffia linearis (Michx) Spach. Narrow-leaved Sundrops. C.S.H. vicinity.—N.M.G.

Kneiffia pumila (L) Spach. Small Sun-drops. Vicinity C.S.H.—J.A.H.

Ludwigia alternifolia L. Rattlebox. Swamps, C.S.H.—N.M.G.

Oenothera biennis L. Common Evening Primrose. Roadsides, C.S.H.—N.M.G.

Oenothera muricata L. Northern Evening Primrose. Sandy or gravelly soils, C.S.H.—N.M.G.

Oenothera oakesiana Robbins. Oakes' Evening Primrose. Roadsides, C.S.H.—G.H.H.

HALORAGIDACEAE.

Myriophyllum humile (Raf) Morang. Low Water Milfoil. C.S.H.—E.N.T.

Myriophyllum pinnatum (Walt) B.W.P. Pinnate Water Milfoil. Lakes, C.S.H.—N.M.G.

Myriophyllum tenellum Bigel. Slender Water Milfoil. 4th lake, C.S.H.—N.M.G.

Proserpinaca palustris L. Mermaid-weed. Oyster Bay; ponds. Babylon.—Jelliffe.

ARALIACEAE.

Aralia hispida Vent. Bristly Sarsaparilla. Jones Woods, C.S.H.—N.M.G.

Aralia nudicaulis L. Wild Sarsaparilla. Jones Woods, C.S.H. N.M.G.

Aralia racemosa L. American Spikenard. Oyster Bay.—Jelliffe.

Aralia spinosa L. Hercules' Club. C.S.H.—N.M.G.

Panax trifolium L. Dwarf Ginseng. Vicinity C.S.H.—G.H.H.

AMMIACEAE.

Aegopodium Podograria var. *variegatum* Bailey. Goutweed. Fish Hatchery, C.S.H.—G.H.H.

Aethusa cynapium L. Fool's Parsley. Marsh, C.S.H.—Jelliffe.

Conium maculatum L. Poison Hemlock. C.S.H. vicinity, D. S.J.

Daucus carota L. Wild Carrot. C.S.H., fields.—N.M.G.
Deringia canadensis (L) Kuntze. Honewort. C.S.H.—N.M.G.
Heracleum lanatum Michx. Cow-Parsnip. Oyster Bay.—Jelliffe.
Hydrocotyle americana L. American Marsh-Pennywort. Wet places C.S.H.—N.M.G.
Lilaeopsis linearia Greene. Lilaeopsis. In mud of marshes, C.S.H.—J.W.H.
Pastinaca sativa L. Wild Parsnip. Common throughout island.—Jelliffe.
Ptilimnium capillaceum (Michx) Mock Bishop-Wood. Brackish water, C.S.H.—J.W.H.
Sanicula canadensis L. Short-styled Snakeroot. Vicinity C. S.H.—G.H.H.
Sanicula marylandica L. Black Snake-Root.—Jelliffe.
Sium cicutaefolium Gmel. Hemlock Water-Parsnip. Dying Pond vicinity, C.S.H.—N.M.G.
Thaspium trifoliatum aureum (Nutl) Britton. Purple Meadow-Parsnip. Syosset, L.I.—H.S.C.
Washingtonia Claytoni, Britton. Hairy Sweet-Cicely. Vicinity C.S.H.—J.A.H.
Washingtonia longistylis Britt. Smoother Sweet-Cicely. C. S.H. vicinity.—J.A.H.

CORNACEAE.

Cornus alternifolia L. Alternate-leaved Dogwood. De Forest Estate, C.S.H.—G.H.H.
Cornus Amomum Mill. Silky Cornel. Oyster Bay.—Jelliffe.
Cornus stolonifera Michx. Red-osier Dogwood. De Forest Estate. C.S.H.—G.H.H.
Cynoxylon floridum (L) Raf. Flowering Dogwood. C.S.H. vicinity.—N.M.G.
Nyssa sylvatica Marsh. Sour Gum. Vicinity C.S.H.—N.M.G.

CLETHRACEAE.

Clethra alnifolia L. Sweet Pepper-bush. Vicinity of lakes, C.S.H.—N.M.G.

PYROLACEAE.

Chimaphila maculata (L) Pursh. Spotted Wintergreen. Moistwoods, C.S.H.—N.M.G.

Chimaphila umbellata (L) Leather-leaf. Pine Barrens, St. James, L. I.—N.M.G.

Pyrola americana Sweet. Round-leaved American Wintergreen. Moist Woods, C.S.H.—N.M.G.

Pyrola elliptica Nutt. Shin-leaf. Vicinity C.S.H.—N.M.G.

MONTROPACEAE.

Hypopitys americana (D.C.) Small. False Beech-Drops. Rich Woods, C.S.H.—N.M.G.

Monotropa uniflora L. Indian Pipe. Rich Woods, C.S.H.—N.M.G.

ERICACEAE.

Uva-Ursi Uva-Ursi (L) Britton. Red Bear berry. Bayville, L. I.; Gilgo Beach.—N.M.G.

Azalea nudiflora L. Pinkster-flower. C.S.H. vicinity.—N.M.G.

Azalea viscosa L. Swamp Pink. Fresh water swamp, C.S.H.—N.M.G.

Calluna vulgaris (L) Hull. Heather. Hodenpyl Estate, Locust Valley, L. I.—N.M.G.

Chamaedaphne calyculata L. Leather-leaf. Pine Barrens, St. James, L. I.—J.W.H.

Epigea repens L. Trailing Arbutus. Vicinity C.S.H.—N.M.G.

Eubotrys racemosa (L) Gray. Swamp Eubotrys. Havemeyer Estate, Locust Valley, L. I.—N.M.G.

Gaultheria procumbens L. Checkerberry. De Forest Estate, C.S.H.—N.M.G.

Kalmia latifolia L. Mountain Laurel. C.S.H. Woods, slopes.—N.M.G.

Ledum groenlandicum Oeder. Labrador Tea. Havemeyer Estate, Oyster Bay, L. I.—N.M.G.

Neoperis mariana (L) Britton. Stagger Bush. Hempstead Plains, Hicksville.—N.M.G.

Oxydendrum arboreum (L) D.C. Sour-wood. Near R.R. depot, C.S.H.—N.M.G.

Rhododendron maximum (L) Torr. Great Laurel. Swamp, 1st lake, C.S.H.—N.M.G.

Xolisma ligustrina Britton. Privet Andromeda. Vicinity C.S.H.—J.A.H.

VACCINACEAE.

Gaylussacia baccata (Wang.) K. Koch. Black Huckleberry. Bayville, N. Y.—N.M.G.

Gaylussacia frondosa (L) T. & G. Huckleberry. Lakes in vicinity, C.S.H.—N.M.G.

Oxycoccus macrocarpus (Ait.) Pursh. Large Cranberry. Marsh near L. Ronkonkema, L. I.—N.M.G.

Vaccinium angustifolium Ait. Dwarf Blueberry. Dry hills, C.S.H.—N.M.G.

Vaccinium corymbosum L. Tall Blueberry. Moist Woods 2nd lake, C.S.H.—N.M.G.

Vaccinium vacillans Kalm. Low Blueberry. Dry Soil, C.S. H.—N.M.G.

Vitis-Idaea Vitis-Idaea (L) Britton. Mountain Cranberry. Rocky soil, Bayville, L. I.—N.M.G.

PRIMULACEAE.

Anagallis arvensis L. Red Pimpernel. Shore of pond at monastery C.S.H.—N.M.G.

Dodecatheon Meadia L. American Cowslip. Glen Cove.Jelliffe.

Lysimachia Nummularia L. Moneywort. Damp Places, C.S. H.—N.M.G.

Lysimachia quadrifolia L. Whorled Loosestrife. Woods, C. S.H.—N.M.G.

Lysimachia producta (Gray) Fernald. Damp Thickets, C.S. H.—N.M.G.

Lysimachia terrestris L. Bulb-bearing Loosestrife. Low ground, C.S.H.—N.M.G.

Naumburgia thyrisiflora (L) Duby. Tufted Loosestrife. Glen Cove.—Jelliffe.

Samolus xoribundos H.B.N. Water Pimpernel. N. and E. Shore, C.S.H.—N.M.G.

Steironema lanceolatum (Walt) Gray. Lance-leaved Loosestrife. Woodbury, L. I.—N.M.G.

Trientalis americana Pursh. Starflower. C.S.H. vicinity.—N.M.G.

PLUMBAGINACEAE.

Limonium carolinianum. Britton. Sea Lavendar. Salt Marshes, C.S.H.—N.M.G.

EBENACEAE.

Diospyros virginiana L. Persimmon. Jones Farm, C.S.H.—N.M.G.

STYROCACEAE.

Halesia carolinum L. Silver-bell. Vicinity, C.S.H.—G.H.N.

OLEACEAE.

Chionanthus virginica L. Fringe-tree. Vicinity C.S.H.—J. A.H.

Fraxinus americana L. White Ash. Common, C.S.H.—N. M.G.

Fraxinus americana L. var. *aecidiosa.* Shull. Huntington Hill Rd.—N.M.G.

Fraxinus nigra Marsh. Black Ash. Oyster Bay.—Jelliffe.

Ligustrum vulgare L. Privet. Cultivated C.S.H.—N.M.G.

Syringa vulgaris L. Lilac. Cultivated C.S.H.—N.M.G.

GENTIANACEAE.

Bartonia virginica (L) Yellow Bartonia. Moist Soil, C.S.H. —N.M.G.

Dasystephana Andrewii (Griseb) Small. Closed Gentian. C. S.H.—G.H.H.

Gentiana crinita Froel. Fringed Gentian.—Jelliffe.

Nymphoides lacunosum (Vent) Kuntze. Floating Heart. Pond near L. Ronkonkema, L. I.—N.M.G.

Sabbatia stellaris Pursh. Marsh Pink. Salt meadow, Gilgo Brach, L. I.—N.M.G.

APOCYNACEAE.

Apocynum androsaemifolium L. Spreading Dogbane. Hempstead Plains, Hicksville.—N.M.G.

Apocynum cannabinum L. Indian Hemp, C.S.H. vicinity.—N.M.G.

Apocynum medium Greene. Intermediate Dogbane. Pine Barrens, St. James, L. I.—N.M.G.

Vinca Minor L. Periwinkle. Cultivated C.S.H.—N.M.G.

ASCLEPIADACEAE.

Asclepias amplexicaulis J. E. Smith. Blunt-leaved Milkweed. Syosset.—H.S.C.

Asclepias exaltata (L) Muhl. Tall Milkweed. Vicinity C. S.H.—J.A.H.

Asclepias pulchra (Ehrb.) Pers. Hairy Milkweed. Fresh water swamps.—C.S.H.

Asclepias purpurascens L. Purple Milkweed. Hempstead Plains, Hicksville. L. I.—N.M.G.

Asclepias quadrifolia Jacq. Four-leaved Milkweed. Oyster Bay—Jelliffe.

Asclepias syriaca L. Common Milkweed. Moist fields, C.S.H. N.M.G.

Asclepias tuberosa L. Butterfly-weed. Hempstead Plain, Hicksville, L. I.—N.M.G.

Asclepias variegata L. White Wilkweed. Glen Cove.—Jelliffe.

Asclepias verticillata L. Whorled Milkweed. Hempstead Plain, Hicksville, L. I.—N.M.G.

Periploca graeca L. Silkvine. W. Side, C.S.H.—D.S.J.

CONVOLVULACEAE.

Convolvulus arvensis L. Small Bindweed. Vicinity C.S.H. —G.H.H.

Convolvulus sepium L. Great Bindweed. Vicinity C.S.H.— G.H.H.

CUSCUTACEAE.

Cuscuta Gronovii Willd. Gronovius' Dodder. Jones Marsh, C.S.H.—G.H.H.

POLEMONIACEAE.

Phlox paniculata L. Garden Phlox. Road to Eugenics Record Office. Vicinity C.S.H.—G.H.H.

BORAGINACEAE.

Cynoglossum officinale L. Hound's Tongue. Vicinity C.S.H. —G.H.H.

Echium vulgare L. Viper's Bugloss. Hodenpyl Estate, Locust Valley, L. I.—N.M.G.

Myosotis scorpioides (L) Forget-me-not. Oyster Bay; escaped.—Jelliffe.

VERBENACEAE.

Verbena hastata L. Blue Vervain. Common throughout island.—Jelliffe.

Verbena urticifolia L. White Vervain. Waste Ground, C.S. H. vicinity.—N.M.G.

LABIATAE.

Agastache nepetoides Kuntze. Catnip Giant Hyssop. Vicinity C.S.H.—G.H.H.

Collinsonia canadensis L. Citronella. Jones Woods, C.S.H, near 1st Lake.—G.H.H.

Cunila origanoides (L) Brit. Stone Mint. Vicinity C.S.H. —N.M.G.

Galeopsis Tetrahit L. Hemp-Nettle. Oyster Bay—Jelliffe.

Glecoma hederacea L. Ground Ivy. C.S.H.—N.M.G.

Koellia flexuosa (Walt) MacM. Narrow-leaved Mountain Mint. Hempstead Plains, Hicksville, L. I.—N.M.G.

Koellia virginiana (L) MacM. Virginia Mountain mint—Jelliffe.

Lamium amplexicaule L. Henbit. Vicinity C.S.H.—J.A.H.

Leonurus Cardiaca L. C.S.H. Waste places—N.M.G.

Lycopus americanus Muhl. C.S.H., rich moist ground.—N. M.G.

Lycopus membranaceus Michx. Rich moist ground, C.S.H. —N.M.G.

Lycopus sessilifolius A. Gray. Gilgo beach, L. I.—N.M.G.

Lycopus virginicus L. Cut-leaved Water Hoarhound. Rich moist ground, C.S.H.—H.S.C.

Marrubium vulgare L. Common Hoarhound. Oyster Bay.—Jelliffe.

Melissa officinalis L. Bee-balm. C.S.H. vicinity.—J.A.H.

Mentha canadensis L. American Wild Mint. Vicinity Biological Laboratory, C.S.H.—G.H.H.

Mentha citrata Ehr. Bergamot Mint. C.S.H. Vicinity.—N. M.G.

Mentha piperita L. Peppermint. Jones Marsh, C.S.H.—G. H.H.

Mentha spicata L. Spearmint. Roadside near Sandspit, C.S. H.—G.H.H.

Monarda didyma L. Oswego Tea. Moist fields, C.S.H.—N. M.G.

Monarda fistulosa L. Wild Bergamot. C.S.H. vicinity.—G. H.H.

Nepeta Cataria L. Catnip. C.S.H. Common.—N.M.G.

Perilla frutescens (L) Britton. Beef-steak Plant. C.S.H., Waste fields.—N.M.G.

Prunella vulgaris L. Self-heal. Roadsides, C.S.H.—N.M.G.
Salvia lyrata L. Wild Sage. Matheson estate, Lloyd Neck, L. I.—N.M.G.
Scutellaria galericulata L. Hooded Willow-herb. Common throughout island.—Jelliffe.
Scutellaria integrifolia L. Larger Skullcap. Hempstead Plains, Hicksville, L. I.—N.M.G.
Scutellaria lateriflora L. Mad-dog Skullcap. C.S.H.—N.M.G.
Stachys hyssopifolia Michx. Hyssop Hedge Nettle. Pine Barrens, St. James, L. I.—N.M.G.
Teucrum canadense L. Wood Sage. Common throughout island.—Jelliffe.
Trichostema dichatoma L. Blue Curls. Vicinity Biological Lab. C.S.H.—G.H.H.

SOLANACEAE.

Datura Stramonium L. Jimson-weed. C.S.H.—N.M.G.
Hyoscyamus niger L. Black Henbane. Glen Cove, L. I.—Jelliffe.
Lycium halimifolium Mill. Matrimony Vine. Vicinity C.S.H. Village.—G.H.H.
Physalis pubescens L. Low Hairy Ground Cherry. C.S.H.—N.M.G.
Physalis virginiana Mill. Virginia Ground-cherry. C.S.H.—Jelliffe.
Physalis viscosa L. Yellow Henbane. Vicinity Biological Lab., C.S.H.—N.M.G.
Solanum Dulcamara L. Climbing Nightshade. C.S.H. moist banks.—N.M.G.
Solanum nigrum L. Deadly Nightshade. Vicinity Biological Laboratory.—G.H.H.
Solanum tuberosum L. Potato. Jones Marsh, C.S.H.—G.H.H.

SCROPHULARIACEAE.

Agalinis maritima Raf. Sea-side Agalinis. Salt marsh, C.S.H.—N.M.G.
Agalinis purpurea (L) Britton. Large Purple Agalinis. Jones Marsh.—C.E.
Antirrhinum majus L. Great Snap-dragon. Cultivated, escaped. C.S.H.—N.M.G.

Castilleja coccinea (L) Spreng. Indian Paint-brush. Oyster Bay.—Jelliffe.

Chelone glabra L. Turtle head. C.S.H. Swamps, and clay streams.—J.A.H.

Cymbalaria Cymbalaria (L) Wettst. Kennilworth Ivy. Vicinity C.S.H.—N.M.G.

Dasystoma flava (L) Wood. Downy False Foxglove. C.S.H. Hillside.—N.M.G.

Dasystoma pedicularia L. Fever-Weed. Pine Barrens, L. I. —N.M.G.

Digitalis purpurea L. Purple Foxglove. Cultivated and escaped.—G.H.H.

Gratiola aurea Muhl. Goldenpert. C.S.H., edge 1st lake.—C.E.

Leptandra virginica (L) Nutt. Beaumont's-root. Common throughout island.—Jelliffe.

Limosella aquatica L. Mudwort. C.S.H. sea wall.—J.W.H.

Linaris canadensis (L) Dumont. Blue Toad-Flax. Hempstead Plains, Hicksville, L. I.—N.M.G.

Linaris Linaria (L) Karst. Butter-and-Eggs. Vicinity C.S.H.—N.M.G.

Melampyrum lineare Lam. Narrow-leaved Cow-Wheat. Beach at Bayville, L.I.—N.M.G.

Mimulus ringens L. Square-stemmed Monkey-flower, C.S.H.—O.E.J.

Paulownia tomentosa (Thunb) Baill. Paulownia. Jones Farm, C.S.H.—O.E.J.

Pedicularis canadensis L. Wood Betony. Hempstead Plains, Hicksville, L. I.—N.M.G.

Scrophularia marylandica L. Maryland Figwort. Woods and thickets, C.S.H.—N.M.G.

Verbascum Blattaria L. Moth Mullen. C.S.H. Waste places, woodsides.—N.M.G.

Verbascum Thapsus L. Great Mullen. C.S.H. Sandspit.—N.M.G.

Veronica agrestis L. Garden Speedwell. Glen Cove.—Jelliffe.

Veronica americana Schwein. American Brooklime. Vicinity C.S.H.—G.H.H.

Veronica arvensis L. Corn Speedwell. Common throughout island.—Jelliffe.

Veronica officinalis L. Common Speedwell. Vicinity C.S.H.—N.M.G.

Veronica peregrina L. Purslane. Speedwell. Common throughout island.—Jelliffe.

Veronica serpyllifolia L. Thyme-leaved Speedwell, St. John's Lake.—Jelliffe.

LENTIBULARIACEAE.

Utricularia gibba L. Humped Bladderwort. C.S.H. vicinity, 2nd lake.—N.M.G.

Utricularia macrorhiza. Le Conte. Greater Bladderwort. Swamp near 2nd lake, C.S.H.—N.M.G.

OROBANCHACEAE.

Leptamnium virginianum (L) Raf. Beech-drops. C.S.H. vicinity—D.S.J.

Thalesia uniflora Brit. Pale Broom-rape. C.S.H. vicinity.—J.A.H.

BIGNONIACEAE.

Bignonia radicans (L) Trumpet-flower. Vicinity C.S.H.—N.M.G.

Catalpa Catalpa. Warder. Catalpa. Cultivated C.S.H.—N.M.G.

PHRYMACEAE.

Phryma Leptostachya L. Lopseed. C.S.H. roadsides.—G.H.H.

PLANTAGINACEAE.

Plantago aristata Michx. Large-bracted Plantain, C.S.H.—N.M.G.

Plantago lanceolata L. Ribgrass. Roadsides, C.S.H.—N.M.G.

Plantago major L. Common Plantain. Roadsides, C.S.H.—N.M.G.

Plantago maritima L. Seaside Plantain. Salt marshes, C.S.H., H.H.Y. and O.S.J.

Plantago Rugelii Dene. Regel's Plantain. Jones Marsh, C.S.H.—C.E.

Plantago virginica L. Dwarf Plantain. Jones Marsh, C.S.H.—C.E.

RUBIACEAE.

Cephalanthus occidentalis L. Button-bush. Kettle hole near Jericho, L. I.—J.W.H.

Diodia teres Walt. Rough Buttonweed. Vicinity C.S.H.—G.H.H.

Galium Aparine L. Cleavers. Coppice, Jones Marsh.—G.H.H.

Galium asprellum Michx. Rough Bedstraw. Oyster Bay.—Jelliffe.

Galium circaezans Michx. Wild Liquorice.—G.H.H.

Galium Claytoni Michx. Clayton's Bedstraw. Salt Marsh, C.S.H.—H.S.C.

Galium Mollugo L. White Bedstraw. Hill road to Huntington. C.S.H.—N.M.G.

Galium tinctorium L. Wild Madder. Oyster Bay.—Jelliffe.

Galium trifidum pusillum L. Small Bedstraw. Pine Barrens, L.I.—N.M.G.

Galium triflorum Ait. Sweet-scented Bedstraw. Vicinity C.S.H.—N.M.G.

Galium verum L. Yellow Bedstraw. Huntington Hill Road.—G.H.H.

Houstonia coerulea L. Bluets.—Jelliffe.

Houstonia longifolia Gaertn. Long-leaved Houstonia. C.S.H. Hempstead Plains, Hicksville, N. Y.—N.M.G.

Mitchella repens L. Partridge Berry. De Forest Estate.—G.H.H.

CAPRIFOLIACEAE.

Lonicera japonica Thumb. Japanese Honeysuckle. C.S.H.—N.M.G.

Lonicera sempervirens L. Coral Honeysuckle. Woods, C.S.H.—G.H.H.

Sambucus canadensis L. American Elder. Roadsides, C.S.H.—N.M.G.

Symphoricarpos racemosus Michx. Snowberry. C.S.H., roadsides.—N.M.G.

Triosteum aurantiacum Bicknell. Scarlet-fruited Horse Gentian. Hempstead Plains, Hicksville, L. I.—N.M.G.

Triosteum perfoliatum L. Feverwort. Oyster Bay, Glen Cove, L. I.—Jelliffe.

Viburnum acerifolium L. Maple-leaved Arrow-wood. Moist Woods, C.S.H.—N.M.G.

Viburnum cassinoides L. White-rod. Swamps, C.S.H.—J.A.H.

Viburnum dentatum L. Arrow-wood. Huntington Hill Road, C.S.H.—N.M.G.

DIPSACACEAE.

Dipsacus sylvestris L. Wild Teasel. C.S.H.—Jelliffe.

CUCURBITACEAE.

Sicyos angulatus L. Star Cucumber. Jones Woods. C.S.H.—G.H.H.

CAMPANULACEAE.

Campanula rapunculoides L. Creeping Bellflower. C.S.H. village and vicinity.—N.M.G.

Specularia perfoliata (L) A. Dc. Venus Looking-glass, C. S.H. vicinity.—N.M.G.

LOBELIACEAE.

Lobelia cardinalis L. Cardinal-flower. C.S.H. vicinity.—N. M.G.

Lobelia inflata L. Indian Tobacco. Road to Sandspit, C.S.H. —N.M.G.

Lobelia Nuttalli R. & S. Nuttall's Lobelia.—Jelliffe.

Lobelia spicata Lam. Pale Spiked Lobelia. Hempstead Plains, Hicksville, L. I.—N.M.G.

Lobelia syphilitica L. Great. Lobelia, Oyster Bay, L. I. — Jelliffe.

CICHORIACEAE.

Apargia nudicaulis (L) Britton. Hairy Hawkbit. C.S.H.—Jelliffe.

Cichorium Intybus L. Chicory. Vicinity C.S.H.—N.M.G.

Cynthia virginica (L) D. Don. Cynthia. Glen Cove.—Jilliffe.

Hieracium aurantiacum L. Orange Hawkweed. Pine Barrens, St. James, L. I. —N.M.G.

Hieracium canadense Michx. Canada Hawkweed, C.S.H. vicinity.—J.A.H.

Hieracium Granovii L. Hairy Hawkweed. Common throughout island.—Jelliffe.

Hieracium marianum Willd. Maryland Hawkweed. Vicinity C.S.H.—J.A.H.

Hieracium murorum L. Wall Hawkweed. Northport, L. I. —Jelliffe.

Hieracium paniculatum L. Panicled Hawkweed. Vicinity C. S.H.—J.A.H.

Hieracium scabrum Michx. Rough Hawkweed. Vicinity C. S.H.—J.A.H.

Hieracium venosum L. Rattlesnake-weed. Vicinity C.S.H.—J.A.H.

Iva frutescens L. Marsh Elder. C.S.H. vicinity, salt marshes.—Jelliffe.

Krigia virginica (L) Willd. Carolina Dwarf Dandelion. Oyster Bay.—Jelliffe.

Lactuca canadensis L. Wild Lettuce. Vicinity C.S.H.—Jelliffe.

Lactuca saligna L. Willow Lettuce. Woods C.S.H.—Jelliffe.

Lactuca spicata (Lam) Hitchc. Tall Blue Lettuce. Jones Marsh, C.S.H.—Jelliffe.

Lactuca virosa L. Prickly Lettuce. Vicinity C.S.H.—Jelliffe.

Lapsana communis L. Succory Dock-cress. Road to Sandspit, C.S.H.—Jelliffe.

Leontodon Taraxacum L. Dandelion. Vicinity C.S.H.—Jelliffe.

Nabalus albus (L) Hook. Rattlesnake-root. Common throughout island.—Jelliffe.

Nabalus altissimus (L) Hook. Tall White Lettuce. Common L.I.—Jelliffe.

Nabalus racemosus (Michx.) D.C. Glaucous White Lettuce. Not infrequent on L. I.—Jelliffe.

Sonchus arvensis L. Corn-Thistle. C.S.H.—Jelliffe.

AMBROSIACEAE.

Ambrosia elatior L. Wild Tansy. E. Shore, C.S.H.—Jelliffe.

Ambrosia trifida L. Great Ragweed.—Jelliffe.

Xanthium americanum Walt. American Cocklebur. Common throughout island.—Jelliffe.

Xanthium commune Britton. Cocklebur. Vicinity C.S.H.—Jelliffe.

Xanthium pennsylvanicum Wallr. Pennsylvania Clotbur.—Jelliffe.

Xanthium spinosum L. Spiny Clotbur. Common throughout island.—Jelliffe.

COMPOSITAE.

Achillea Millefolium L. Yarrow. C.S.H.—N.M.G.
Anaphalis margaritacea (L) B. & H. Pearly Everlasting, Pine Barrens, St. James, L. I.—N.M.G.
Antennaria neglecta Greene. Field Cat's-foot. Syosset.—H. S.C.
Antennaria neodioica Greene. Smaller Cat's-foot. C.S.H. vicinity.—N.M.G.
Antennaria plantaginafolia (L) Richards. Plantain-leaf. Everlasting. Vicinity C.S.H.—J.A.H.
Anthemis arvensis L. Corn Camomile. C.S.H.—G.H.H.
Anthemis Cotula L. Dag's Camomile.C.S.H.—G.H.H.
Arctium Lappa L. Great Bur. Vicinity C.S.H.—N.M.G.
Arctium minus Bernh. Common Burdock. Jones marsh, Vicinity C.S.H.—G.H.H.
Artemisia caudata Michx. Tall Wormwood, C.S.H.—Jelliffe.
Artemisia Stelleriana Bess. Beach Wormwood. Bayville, L. I.—N.M.G.
Artemisia vulgaris L. Common Mugwort, C.S.H.—Jelliffe.
Aster acuminatus Michx. Whorled Aster.—Jelliffe.
Aster cordifolius L. Common Blue Wood Aster. C.S.H.—J. A.H.
Aster divaricatus L. White Wood Aster, Vicinity C.S.H.—J.A.H.
Aster dumosus L. Bushy Aster. Vicinity C.S.H.—J.A.H.
Aster ericoides L. White Heath Aster. Vicinity C.S.H.—J. A.H.
Aster Herveyi Gray. Hervey's Aster. C.S.H.—N.M.G.
Aster laevis L. Smooth Aster. Oyster Bay.—Jelliffe.
Aster lateriflorus Britton. Starved Aster. Vicinity C.S.H.—J.A.H.
Aster macrophyllus L. Large-leaved Aster. Oyster Bay. —Jelliffe.
Aster multiflorus Ait. Dense-flowered Aster.—Jelliffe.
Aster novae-angliae L. New England Aster.—Jelliffe.
Aster novae-belgii L. New York Aster. Fern Belt. Marsh. —H.S.C.
Aster paniculatus Lam. Tall White Aster. Vicinity C.S.H. —J.A.H.

Aster paniculatus acutidens Burgess. Vicinity C.S.H..—J. A.H.

Aster patens Ait. Late Purple Aster. Vicinity C.S.H.—J. A.H.

Aster puniceus L. Red-stalk Aster. Vicinity C.S.H.—J.A.H.

Aster subulatus Michx. Annual Salt Marsh Aster. Salt marsh, C.S.H.—N.M.G.

Aster salicifolius Lam. Willow Aster Vicinity C.S.H.—J.A.H.

Aster tenuifolius L. Perennial Salt-marsh Aster. Marsh, C. S.H.—Jelliffe.

Aster tradescanti L. Michaelmas Daisy. Common throughout island.—Jelliffe.

Aster undulatus L. Wavy-leaf Aster.—J.A.H.

Aster vimineus Lam. Small Aster. Vicinity C.S.H.—J.A.H.

Baccharis halimifolia L. Groundsel-tree. Gilgo Beach, L.I. —N.M.G.

Bidens bipinnata L. Spanish Needles. Vicinity C.S.H. — G.H.H.

Bidens connata Muhl. Purple stemmed Swamp Beggar Ticks. Common throughout island.—Jelliffe.

Bidens cernua L. Smaller Bur-Marigold. C.S.H.—G.H.H.

Bidens frondosa L. Beggar-ticks. Roadsides, C.S.H.—G.H.H.

Centaurea Cyanus L. Corn Flower. Havemeyer Estate near Oyster Bay, L. I.—G.H.H.

Centaura nigra L. Black Knapweed. Near R.R. Depot, C.S. H., L. I.—G.H.H.

Chrysanthemun Parthenium L. Feverfew. Matheson Estate, C.S.H.—G.H.H.

Chrysanthemun Leucanthemum L. Ox-eye Daisy. Roadsides, fields, C.S.H.—G.H.H.

Chrysopsis mariana L. Maryland Golden Aster. Pine Barrens near L. Ronkonkema, L. I.—N.M.G.

Chrysopsis falcata (Pursh) Ell. Sickle-leaved Golden Aster. Sandy Soil, Bayville, L. I.—N.M.G.

Cirsium arvense L. Scop. Canada Thistle. Common throughout island.—Jelliffe.

Cirsium discolor (Muhl) Spreng. Field Thistle. Hempstead Plains, Hicksville, L. I.—N.M.G.

Cirsium horridulum Michx. Yellow Thistle. Oyster Bay.—Jelliffe.

Cirsium lanceolatum L. Common Bur. Vicinity, C.S.H.—N. M.G.

Cirsium odoratum (Muh) Porter. Fragrant thistle. C.S.H.—N.M.G.

Coreopsis tinctoria Nutt. Golden Coreopsis. Cultivated, C. S.H.—J.H.H.

Dahlia pinnata Cav. Escaped from cultivation.—C.E.

Doellingeria umbellata (Mill.) Nees. Tall Flat-top Aster. Oyster Bay, L. I.—Jelliffe.

Erechtites hieracifolius (L) Raf. Fire-weed. Salt Marsh, C.S.H.—H.S.C.

Erigeron annuus (L) Pers. Sweet Scabious. C.S.H., fields. —N.M.G.

Erigeron philadelphicus L. Philadelphia Fleabane. Oyster Bay, L. I.—Jelliffe.

Erigeron pulchellus Michx. Robin's Plantain. C.S.H.—N. M.G.

Erigeron ramosus Walt. Daisy Fleabane. Vicinity C.S.H. —N.M.G.

Eupatorium hyssopifolium L. Hyssop--leaved Thoroughwort. Vicinity C.S.H.—N.M.G.

Eupatorium perfoliatum L. Boneset. Salt Marsh, C.S.H.—N.M.G.

Eupatorium purpureum L. Joe-Pye Weed. Roadsides, C.S.H. —N.M.G.

Eupatorium sessilifolium L. Upland Boneset. Glen Cove; Oyster Bay.—Jelliffe.

Eupatorium urticaefolium Reichard. White Snake-root. Oyster Bay.—Jelliffe.

Euthamia graminifolia (L) Nutt. Bushy Golden rod. Upper Marsh near Fish Hatchery.—J.A.H.

Euthamia tenuifolia L. Greene. Slender Fragrant Golden rod. Syosset,—H.S.C.

Galinsoga parviflora (Cav) Galinsoga. Fields, waste places, C.S.H.—N.M.G.

Gnaphalium Helleri. Britton. Heller's Everlasting. C.S.H.—Jelliffe.

Gnaphalium obtusifolium L. Sweet Everlasting. Common throughout island.—Jelliffe.

Gnaphalium uliginosum L. Mouse-ear. Common throughout island.—Jelliffe.

Helenium autumnale L. False Sunflower. Common throughout island—Jelliffe.

Helianthus angustifolius L. Narrow-leaved Sunflower. Oyster Bay—Jelliffe.

Helianthus annuus L. Upper Marsh, C.S.H.—Jelliffe.

Helianthus divaricatus L. Rough Sunflower. Common thoughout island.—Jelliffe.

Helianthus giganteus L. Tall Sunflower. Lloyds point; C. S.H.—N.M.G.

Helianthus strumosus L. Pale-leaved Wood Sunflower. Hempstead Plains, Hicksville, L. I.—N.M.G.

Heliopsis scabra Dunal. Rough Ox-eye. Vicinity C.S.H.—G.H.H.

Inula Helenium L. Elecampane. Oyster Bay, L. I.—Jelliffe.

Ionactis linariifolius (L) Greene. Stiff Aster. Syosset.—H.S.C.

Lacinaria scariosa (L) Hill. Large Button-Snakeroot. Common L. I.—Jelliffe.

Leptilon canadense Britton. Canada Fleabane. Vicinity Biological Lab. C.S.H.—N.M.G.

Matricaria matricarioides (Less.) Porter. Rayless Camomile. Hempstead Plain, Hicksville, L. I.—N.M.G.

Mikania scandens (L) Willd. Climbing Hempsweed. Frequent, L. I.—Jelliffe.

Nabalus trifoliolatus Cass. Tall Rattlesnake-root. Road to Eugenics Record Office, C.S.H.—N.M.G.

Pluchea camphorata L. Spicy Fleabane. Salt marsh, C.S.H. —N.M.G.

Rudbeckia hirta L. Black-eyed Susan. Hempstead Plain. Hicksville, L. I.—N.M.G.

Senecio aureus L. Golden Ragwort. Common throughout island.—Jelliffe.

Senecio vulgaris L. Common Groundsel, C.S.H.—Jelliffe.

Sericocarpus asteroides (L) B.S.P. Toothed White-topped Aster. Near 1st lake, C.S.H.—N.M.G.

Sericocarpus linifolius L. Narrow-leaved White-topped Aster. Hempstead Plains, Hicksville, L. I.—N.M.G.

Solidago bicolor L. White Golden rod. Vicinity C.S.H.—J. A.H.

Solidago caesia L. Blue-stemmed Goldenrod. Vicinity C.S.H. —J.A.H.

Solidago canadensis L. Canada Goldenrod. Vicinity C.S.H.— N.M.G.

Solidago flexicaulis L. Broad-leaved Goldenrod. Oyster Bay, L. I.—Jelliffe.

Solidago juncea Ait. Early Goldenrod. Vicinity C.S.H. — J.A.H.

Solidago nemoralis Ait. Dwarf Goldenrod. Vicinity C.S.H. —N.M.G.

Solidago odora Ait. Sweet Goldenrod. Pine Barrens near St. James, L. I.—N.M.G.

Solidago rugosa Mill. Pyramid Golden Rod. Vicinity C.S. H.; Syosset, L. I.—H.S.C.

Solidago sempervirens L. Seaside Goldenrod. Salt Marsh, C.S.H.—Jelliffe.

Solidago serotina Ait. Late Goldenrod. Oyster Bay.—Jelliffe.

Sonchus asper (L) Hill. Spiny Sow-thistle. Vicinity C.S.H. —Jelliffe.

Tanacetum vulgare L. Tansy. C.S.H.—N.M.G.

Veronia noveborocensis (L) Willd. New York Ironweed. Jones Marsh; Roadsides, C.S.H.—J.H.H.

HIBERNATION AND REJUVENATION, EXEMPLIFIED BY NORTH AMERICAN HERBS.

THEO. HOLM.

(*With five plates drawn from nature by the author.*)

Rejuvenation is generally preceded by hibernation so far as concerns the perennial herbs, and some few, which typically are not perennial, but which occasionally may persist for two or three years. The method of rejuvenation may be indicated, however, already at the seedling-stage during the first season. The stage of hibernation may be represented by aerial or subterranean structures, notably by the latter.

The first hibernation is frequently an illustration of the future habit of the species with regard to the development of the various organs, which are needed for securing a vegetative reproduction, the fundamental structure by which the plant acquires the power of rejuvenation. The hibernation, including the protection of the plant so as to resist the cold, and at the same time securing the persistence of the individual by the accumulation of food-substances, in roots, stems or leaves, is effected by manifold structures, peculiar to a number of genera, or only to certain species. Structures exactly uniform are characteristic of only a relatively small number of families. If these various structures had been studied in the North American plants especially, they would constitute a valuable characterization of genera and species in connection with the well known floral and foliar. The study of vegetative reproduction, however, is sometimes a difficult subject; it may require no small amount of observation, and for quite a considerable time.

Hibernation and rejuvenation thus constitute two phases of plant-life, illustrating in a remarkably clear manner the power of the plant to adapt itself to the environment in conformity with its requirements for existence. The numerous and highly diversified structures observed in this particular

respect may well be regarded as a result of the combined efforts of the plant to resist and conquer in the struggle for its existence, within certain limits beyond which its vitality becomes menaced. Some certain external structures in the line of vegetative reproduction, for instance in the development of the root-system and the subterranean stem are fixed and absolutely constant in a number of genera and species; they are frequently accompanied by internal structures, which are equally fixed and constant in many families. These external and internal peculiarities may thus both represent fixed characters, but the internal especially are often accompanied by such modifications, which depend on the nature of the environment, the epharmonic. Many, if not most of the epharmonic structures appear, however, in a very regular manner and, to a great extent, in strict conformity with the plasticity of the species. The combination of these vegetative structures with those pertaining to the floral reproduction "in toto," may be considered as an expression of some kind of individuality possessed by the plants. Hibernation and rejuvenation, giving us a picture of the beginning and final structures of the vegetative organs, contain many points in favor of a striking, adaptive power of the plants, which appear far beyond any simply forced adaptation, forced upon the plant by the environment alone.

While the very first period of the seedling-stage is not marked by many structural, principally external, differences, the autumnal stage is the one, where the morphological peculiarities of the perennial species begin to appear, preparing for the first hibernation and succeeding rejuvenation. We know that the majority of the dicotyledonous plants germinate with epigeic cotyledons, and that the shape of the cotyledons is remarkably uniform in numerous genera, besides that the structure of the hypocotyl and the primary root is very uniform; in some few Dicotyledones the cotyledons are hypogeic, free or remaining enclosed within the seed. In the Monocotyledones the cotyledon is hypogeic in all the *Gramineae* and *Cyperaceae*, and epigeic only in some relatively few genera of the other families. Characteristic of all the *Orchidaceae* is the development of the non-differentiated embryo into a small tuberous body, at the apex of

which the rudimentary cotyledon subtends the plumule. The uniformity in structure during the first period of the seedling-stage in the Dicotyledones disappears sooner or later during the summer, when the stem with the roots begin to increase in length and thickness according to the habit of the species. There is, however, a wide gap between germination and the first hibernation. The possibility of the seeds to strike ground suitable to their germination is in many plants very limited, some being more particular in this respect than others, and some requiring several years before they are able to germinate. But even if the seeds manage to germinate, the first summer is a most critical period for these to develop further. We are speaking of perennial herbs only, and we have noticed for many years how very few seedlings of certain species survive the first summer; very many succumb, becoming, so to speak, crowded out by the numberless annuals, or destroyed by unfavorable climatologic conditions, droughts especially. But those that manage to pull through the summer, and to reach the autumnal stage, these are safe, and capable of persisting through the winter, buried in the soil or covered by fallen leaves. The first sign of rejuvenation proves their vitality, and from that time the danger of becoming arrested in their development is much lessened. The various factors important to the seed to germinate, to the seedling to become prepared for the first hibernation, these factors, though essentially the same, may exercise an influence of highly different extent upon the various plants. Therefore we observe certain species to be remarkably resistant to the influence of climate and soil, thus their seedlings may be found in numbers, and the species growing in abundance, owing to the germinative power of the seed, and the strength of the seedling to continue its growth undisturbed. The social, the abundant occurrence of certain species, may sometimes not depend upon the germination of many seeds, but simply upon the original establishment of some few individuals of which the vegetative reproduction is effected by runners, stolons, or root-shoots.

The very first indication of the species to become perennial is exemplified by various modifications in the structure

of the seedling. Among the Dicotyledones an early appearance of secondary tissues in the primary root is a sure sign (certain *Umbelliferae, Claytonia, Panax, Galactia*); moreover the early development of a secondary root-system at the expense of the hypocotyl and the primary root (*Ranunculus, Dionaea*). An early increase in thickness of the hypocotyl (*Scrophularia, Collinsonia, Sanguinaria*); the appearance of cotyledonary buds (*Triadenum*, many *Labiatae, Leguminosae*), which generally remain dormant during the first season; the development of the primary shoot into a bulb or a tuber (*Dentaria bulbifera, D. laciniata*); the persistence of some of the basal internodes and buds of the primary shoot (*Phryma, Hypericum*), or finally, by an early appearance of buds upon the lateral roots (*Rhexia*).

Among the Monocotyledones the future perennial growth is marked by only a few distinct structures owing to the complete absence of secondary tissues in the roots, as well as the frequent non-development of a hypocotyl. But the early increase in thickness of the primary axis so as to form a tuber (*Arisaema, Dioscorea*) or a bulb indicates a perennial habit. In the perennial *Gramineae, Cyperaceae* and *Juncaeae* the leaves developed during the first summer subtend buds, which winter over and develop during the succeeding spring into stolons or ascending shoots. These various structures thus represent the foundation of vegetative reproduction, and they are constant and characteristic of a number of genera and species.

The rejuvenation appears in conformity with these structures, and especially in accordance with the function of the hibernating buds to develop as an ascending, aerial shoot, as runners or as subterranean stolons. An aerial shoot, frequently purely vegetative for some years, or a single green leaf may be the first sign of rejuvenation, but generally accompanied by subterranean structures such as rhizomes, tubers, bulbs or even root-shoots, for the duration of the species may be prolonged by means of the roots, when the primary axis does not persist for more than one season (*Rhexia*), or for two years (*Strophostyles*). Rejuvenation in the manner of a purely vegetative shoot, vegetative for several years, is characteristic of *Gramineae, Cyperaceae, Jun-*

caceae, and also of many Dicotyledones of the various families. The development of a single, green leaf may be observed in several Monotyledones: *Similacina, Oakesia, Medeola* etc., and in a number of Dicotyledones with rhizomes viz: *Podophyllum, Sanguinaria, Jeffersonia, Dentaria* etc., or with tuberous roots viz: *Panax*, many *Umbelliferae* etc.

While thus the structure of the seedlings at the very earliest stage is strikingly uniform in many species, genera and even families, mono- as well as dico-tyledonous, the withering of the cotyledons marks a new period of growth resulting in structures of great diversity in accordance with the requirements of the plant, when preparing for the first hibernation. The first rejuvenation shows us in the structure of the subterranean part of the primary shoot, how the final habit will be, and not infrequently axes of secondary order may also begin to appear at this stage, in the form of runners, stolons, tubers, etc. But such conformity does not exist, when we examine the possible correlation between the development of the plant-organs, combined with each other. For the development of the primary root as a large storage-root may be accompanied by a single leaf for several years (*Erigenia, Archemora*), by a small rosette of leaves (*Claytonia*), or by a vegetative shoot as in *Galactia*. The swollen hypocotyl may be accompanied by a single leaf for several years (*Sanguinaria*), or by a vegetative shoot (*Scrophularia, Collinsonia*). The young rhizome, as it appears during the first period of rejuvenation, may develop a single leaf in *Podophyllum, Jeffersonia, Dentaria, Smilacina*, or a vegetative shoot as in *Leptandra, Lysimachia*. Finally the tubers and the bulbs may represent the axis of first order, the primary, or they may be axilllary, sessile or terminating long stolons, as the tubers in *Hydrocotyle Americana, Scutellaria parvula, S. lateriflora, Stachys*, and the bulbs in *Claytonia Chamissonis, Oxalis violacea* etc.

Another peculiarity, which shows a corresponding independence of these structures, consists in the foliage of certain plants to remain fresh and green throughout the winter, although they are not of the evergreen type. While several of the perennial herbs disappear from the surface of the soil so soon as the fruits have matured, as early as during the

first part of the summer (*Dicentra, Dentaria, Anemone, Erythronium*), some others, and very many indeed, may be observed to hibernate with some aerial leaves, remaining green and active throughout the winter. Among these are species of strikingly different habits: nearly all the *Gramineae,* notably *Panicum,* of which the overwintering leaves are much smaller, but of a much firmer structure than those developed in the spring; all the *Carices, Iris, Rumex, Stellaria, Hepatica Thalictrum, Viola* (many species), *Linum, Hypericum, Oxalis, Geum, Fragaria, Potentilla, Phlox subulata, Gratiola, Glechoma,* and many *Compositae,* notably *Arnica, Antennaria, Aster, Solidago* etc.

These various structures briefly described above, thus indicate the duration of the plants to extend for several years, and the growth from the seedling-stage to the first rejuvention incl. corresponds sometimes with the one, which characterizes the biennials. The life of the biennials comprises a purely vegetative stage during the first season, from the germination to the hibernation incl., and a mostly purely floral in the second season, the rejuvenation, followed by the death of the individual. In several of the biennial plants the primary root develops as a strong tap-root, accompanied by a corresponding growth of the hypocotyl, while the aerial shoot, during the first season, remains extraordinarily short, unbranched, with the crowded leaves forming a rosette, persisting in a fresh condition through the winter (*Arabis laevigata,* many *Compositae* etc.), or withering at the close of the first season (*Lappa* according to Warming.) The rejuvenation is marked by the development of a floral shoot with stretched internodes, more or less leafy, and frequently even ramified (*Cynoglossum, Onosmodium* etc.) Some of the biennials imitate the annuals by a feeble development of the primary root, and by a very early flowering (*Draba verna, Cerastium viscosum* L., *C. vulgatum* L. etc.) With exception of some cultivated grasses, no biennials are known among the Monocotyledones. The development of a tap-root and a hibernating rosette of leaves is, as shown in the preceding, characteristic of several perennials, but in these the first floral stage may not appear already in the second year, but several years afterwards, and the floral stage may become

repeated every year so long as the individual persists. Moreover the perennials are frequently capable of producing a secondary root-system from the basal internodes, already during the first season, which does not occur in the biennials.

Transitions from the annual to the biennial type are known, and several cases have been described by Irmisch and Hildebrand, notably among the *Cruciferae, Compositae,* and cultivated *Gramineae; Echinospermum Lappula* occurs as annual and biennial (Irmisch), and the habit is quite different; the annual specimens develop no rosette of leaves, and the cauline are only a few; annual specimens of *Hyoscyamus niger* have been described as a distinct species: *H. agrestis.* Alexander Braun has made the interesting statement, that hybrids of biennials may become perennial by the development of shoots, because the sexual reproduction is inferior.

Furthermore certain apparently annual plants may be difficult to classify in this respect. Irmisch observed that in *Melilotus officinalis, M.albus* and *M.macrorrhizus* the primary shoot is tall, purely vegetative and dies down to the ground at the close of the first season, but leaving the hypocotyl and the cotyledonary buds intact; during the following spring these buds develop into floral shoots, and the individual dies immediately after the maturing of the fruits. *Strophostyles umbellata* (Muehl.) Britton grows in the same manner, but lives one year longer, since the primary root with its ramifications produces many shoots in the third season, of which several reach the flowering stage, but wither completely after the maturing of the seeds; we observed as many as 17 shoots developed on one single, lateral root, but those (three to five) that were developed from the primary root, were much stronger.

Transitions from annual to perennial seem to be more frequent, and several cases have been recorded. According to Scott Elliot (fide Henslow l. c.) certain European annuals of cultivation have become perennials in South Africa. The Stock and the Mignonette were by I. O. Hooker observed to be perrennial in Tasmania. De Vries mentions *Phaseolus multiflorus* as being typically an annual, but that it sometimes produces a tuberous root, which may winter over and enable the plant to become perennial; furthermore that a per-

ennial variety of rye is cultivated in Russia. Irmisch observed *Hypericum humifusum* and *Malva neglecta* to occur as both perennials and annuals, although they are typically annuals. From this continent we have reported *Cyperus flavescens* L., *Tragus racemosus* Hall., *Delphinium Consolida* L., *Hypericum nudicaule* Walt., and *Arabis lyrata* L. as being perennial in certain localities, and more recently we have found many perennial specimens of *Hypericum Canadense* L. and *H. mutilum* L. (Fig. 46.) It would thus appear as if the typically annual species of *Hypericum* show a tendency to become perennial. A corresponding variation from annual to perennial occurs also in *Linum Virginianum* L., where small vegetative shoots appear late in the fall, and persist through the winter. We have thus arrived at the question, how the perennial habit is actually effected, and how such habit may be traced to the seedling-stage during the first summer and be continued during the first hibernation until rejuvenation begins. The methods by which it is effected are very distinct, and it would be a very difficult task to combine them in the manner of classification. We, therefore, prefer to describe some of the most characteristic methods independently of each other, but, so far as possible, in accordance with the organs, which are the most active and influential with respect to enabling the species to become perennial. As mentioned in the preceding pages these organs may be: (1) the primary root, (2) the secondary root-system, (3) the hypocotyl, (4) the cotyledonary buds, (5) the plumule and, though seldom, the early development of buds upon the lateral roots.

I.—THE PRIMARY ROOT.

Erigenia bulbosa Nutt. (Fig. 1) represents the very simplest type of a perennial herb, since the primary root persists through the whole life of the individual, and since no secondary roots become developed; moreover because the hibernating stage shows only the root and a bud, from which the aerial stem or stems become developed. The seedling has only one cotyledon, epigeic and with a long, slender petiole; the primary root represents a small tuberous body taper-

ing gradually into a filiform, unbranched apex. At the close of the first season the only part that persists is the small, globose base of the root (the primary) bearing a minute bud, covered by a scale-like leaf. The first rejuvenation takes place in the very early succeeding spring, and this stage is marked by a single aerial leaf with a long petiole and a ternately divided blade; some few short, slender lateral roots have developed from the primary. For five or six years the hibernation and rejuvenation show the same structure, with the only differences that the number of scale leaves becomes increased to three, and that the aerial leaf attains the same size and shape as the later developed cauline. At the time of flowering a single, terminal stem develops from the bud, beside that some lateral (two or three) may appear from the axils of the scale-leaves. *Erigenia* is polycarpous.

Claytonia Virginica L. (Fig. 2). Likewise *Erigenia* the seedling has only one cotyledon and the long, primary root is swollen at the base; there is no hypocotyl. During the first season the base of the root increases rapidly in thickness, while the slender apical portion dies off before the first hibernation. The first hibernation is thus marked by only a small, roundish tuberous root and a bud from which a few leaves become developed at the first rejuvenation; the root shows then many transverse wrinkles, and several long, lateral roots become developed. Some three or four years elapse before the inflorescenses appear; these are axillary, the small shoot thus representing a monopodium, but all the leaves fade away during the spring.

Calandrinia pygmaea Gray (Fig. 3) differs from *Erigenia* and the *Claytonia*, described above, by germinating with two cotyledons, and by the primary root becoming a deep, fleshy, and very thick taproot with many transverse wrinkles indicating its contractile power. The inflorescenses do not appear until several years after the germination, and they all are axillary as in *Claytonia*.

Characteristic of these three plants is thus the persistence of the primary root, the non-development of the secondary roots, the absence of a hypocotyl, and the subterranean stem being only represented by extraordinarily short inter-

PLATE 1.

PLATE 1.

Fig. 1. *Erigenia bulbosa* Nutt. in the third year, showing the globose primary root with four slender branches, and the green leaf with a small, scale-like leaf at its base; natural size.

Figure 2. *Claytonia Virginica* L. Germination. Cot. = the cotyledon; natural size.

Figure 3. *Calandrinia pygmaea* Gray. Germination. Cot. = the cotyledons; enlarged.

Figure 4. *Panax quinquefolium* L. Hibernation; natural size.

Figure 5. Same species. Rejuvenation. St. = the stem with a leaf (L.) natural size.

Figure 6. Same species. Part of the rhizome of a mature specimen, showing the subterranean internodes, the base of the primary root, and the base of the aerial stem (St.); 2 × natural size.

Figure 7. *Panax trifolium* L. Germination. S = the seed enclosing the cotyledons; 2 × natural size.

Figure 8. Same species. The rhizome and the root of a mature specimen. St. = Base of the flowering stem; natural size.

Figure 9. *Galactia pilosa* Ell. Rejuvenation. Cot. = the scars of the cotyledons with the dormant buds; two-thirds of the natural size.

nodes. The monopodial structure of the shoot in *Claytonia Virginica* and *Calandrinia* recurs, however, in several of the other species of *Claytonia*, but of which the habit is very different.

A more advanced development of the primary root and the subterranean stem is to be observed in the following species of *Panax*.

Panax quinquefolium L. (Figs. 4-6). The seedling germinates with two hypogeic cotyledons, and the primary root is a deep, swollen tap-root. A long-petioled leaf with an ample, ternate blade develops already during the first season, in the month of June; a small bud is visible at the base of this leaf, and remains dormant until next spring. At the first hibernation only the root and the bud persist. The first rejuvenation consists of the development of four scale leaves, exactly alternate, and a short, aerial stem bearing at its apex a bud and a ternate leaf with a distinct, but relatively short petiole. In mature specimens the root is quite large, sometimes more or less irregularly branched, and frequently with several long, slender ramifications. A short, vertical, but subterranean stem is now visible, and the scale leaves, three

to four, are exactly alternate; of these the two uppermost subtend small buds, the apical growing out to produce an aerial shoot, the basal remaining dormant. The root and the short, subterranean stem represent the stage of hibernation, the development of an aerial shoot marks the rejuvenation.

Panax trifolium L. (Figs. 7-8) shows at the seedling-stage the same type of root (the primary) as *Claytonia* (Fig. 2), while the two cotyledons are hypogeic, remaining enclosed within the seed. A green leaf with three leaflets appears already during the first season. At the stage of the first hibernation the filiform apex of the root has withered, and only a small, globular root with a bud persists through the winter. During the subsequent years the root retains its globular shape, and a small, vertical, subterranean stem with several scale-leaves, exactly alternate, become gradually developed. The root-system consists only of the primary and some few, slender lateral.

These two species of *Panax* have in common that the cotyledons (two) are hypogeic; that the primary root persists, but is of a different shape; that the aerial shoot is borne upon a vertical, but very short rhizome with scale-leaves, exactly alternate.

Galactia pilosa Ell. (Fig. 9). The cotyledons are hypogeic, and there is no hypocotyl; the primary root is developed as a tap-root already at the seedling stage. A small aerial, vegetative shoot appears during the first summer; it dies down to the ground during the fall, leaving only a few basal internodes and the root still active. The first rejuvenation depends upon the development of an aerial shoot from one of the axillary buds of the basal internodes, while the cotyledonary buds (Cot. in fig. 9) remain dormant; the primary root has now increased in thickness, and continues to do so until the death of the individual. No other root-system becomes developed in this species, and it is interesting to notice, that in the southern species *G. Elliottii* Nutt. the prostrate stems root freely at the nodes, the roots showing the same structure as the primary root of *G. pilosa*.

Archemora rigida DC. may also be referred to this type of perennials, although the primary root persists for only a

few years, becoming replaced by a secondary system. Figure 10 shows a seedling, collected early in May. The primary root is long, very slightly swollen, and sparingly ramified. There is no hypocotyl; the cotyledons subtend no buds, and only one green leaf appears during the first summer. Secondary tissues have already begun to appear in the primary root, at this very early stage. During the first summer the primary root continues to increase in thickness, but only in the basal portion, close to the cotyledons, the long, slender apex withering gradually. The first hibernation is only marked by the persistence of the small, tuberous, primary root with a minute bud, covered by a scale-like, membranaceous leaf. The first rejuvenation is effected by the development of two green leaves, surrounded at the base by the scale-leaf, and furthermore by the development of a long, slightly swollen secondary root, proceeding from the very short internode beneath the scale-leaf; some few, mostly two, thin secondary roots have also been developed from the same place. The stage of germination, hibernation and rejuvenation thus show us a typical perennial plant with a hibernating bud and a system of storage roots (the primary and the secondary), which are contractile before the increase sets in. The individual remains purely vegetative for several years, presumably about 5 years. *Cicuta maculata* L. germinates in the same manner as *Archemora*.

The primary root thus plays a rôle of great importance to this group, even if it does not persist in *Archemora* and *Cicuta;* in all the others the primary root persists throughout the life of the plant. But characteristic of this group is the non-development of a hypocotyl, as well as the rhizome, being exceedingly short, when such is actually present. In *Archemora* and *Cicuta* the development of a secondary root-system makes an approach to the next group, where such system replaces the primary root already at the seedling-stage, besides that the hypocotyl, although well developed by the germination, fades away completely. So far as concerns the seedling-stage and the first hibernation *Archemora* and *Cicuta* belong naturally to the same group as *Erigenia* and the others. The first rejuvenation shows, on the other hand, the same peculiarities as are characteristic of the seedling

stage of the subsequent group, where a secondary root-system makes an early appearance.

II.—THE SECONDARY ROOT-SYSTEM.

A future perennial habit is shown by some plants by the very early development of a secondary system of roots, while the hypocotyl and primary root fade away completely. This structure is frequent and characteristic of most of the perennial Dicotyledones, which have only fibrous roots. *Ranunculus abortivus* L. may be selected as an example. The young seedling (Fig. 16) shows the common structure of seedlings in general: the long primary root, the distinct hypocotyl, and the plumule, having developed a small leaf. But a few weeks later we observe that the hypocotyl begins to bend towards the ground, and that secondary roots proceed from beneath the cotyledons, while several (4) green leaves have become developed from the plumule (Fig. 17). By following the further development of the seedling we notice a very

PLATE 2.

Figure 10. *Archemora rigida* DC. Germination. Cot. = the cotyledons; R = the primary root; natural size.

Figure 11. Same species. Rejuvenation; a specimen in its second year. R = the swollen, primary root; r. = secondary roots; natural size.

Figure 12. Same species. Rejuvenation; a specimen in its third year. letters as above; enlarged.

Figure 13. Same species. Hibernation; rhizome of a mature specimen with the roots and a large bud at the base of the aerial stem; natural size.

Figure 14. *Cicuta maculata* L. Rejuvenation; rhizome of a mature specimen with the roots and the base of the flowering stem; natural size.

Figure 15. Same species. Hibernation; a bud detached from the rhizome of an old specimen to produce a new individual; two thirds of the natural size.

Figure 16. *Ranunculus abortivus* L. Germination; R = the primary root; Hyp. = the hypocotyl; cot. = the cotyledons; 3 × natural size.

Figure 17. Same species. An older seedling; r = the first two secondary roots; other letters as above; 3 × natural size.

PLATE 2.

great change, since, as shown in figure 17, the hypocotyl and the primary root have begun to fade away, replaced by a new set of roots, which pull the young, leafy shoot down into the ground. As soon as the seedling has dropped the hypocotyl and the primary root, it shows the final vegetative habit: a rosette of leaves and fibrous roots. The foliage withers during the summer, but the root-system with a bud persists through the winter. During the following early spring the bud develops into a rosette of leaves and a terminal floral shoot. The species is not biennial as described by Gray, but perennial, as we have observed many specimens with an old flowering stem still attached from the preceding year. The rejuvenation then depends upon the development of buds in the axils of the basal leaves, and these buds may be readily observed, when the plant is maturing the fruits.

As stated above this type of vegetative reproduction, shown already at the seedling-stage, is common to many plants of different families, for instance several of the other species of *Ranunculus*, *Saxifraga Virginiensis* L., *Dionaea*, *Sarracenia purpurea* L., *Sanicula* etc. They are plants of a cespitose habit with the leaves forming a more or less distinct rosette, and with numerous fibrous roots. In *Dionaea*, however, the primary axis is creeping, but the internodes are exceedingly short, thus the foliage is very much crowded, and resembles a rosette. Consequently *Dionaea* is not acaulescent as described by Gray, Bentham and Hooker and several other authors. By the development of a distinct primary root, though of short duration, *Dionaea* differs from most of the other *Droseraceae*.

Cimicifuga racemosa Nutt. forms a transition from this group to the next. (III.) The first stage of the seedling agrees entirely with that of *Ranunculus abortivus* (Fig. 17), but only the basal part of the hypocotyl and the primary root dies off. The upper part of the hypocotyl persists, and the stage of the first hibernation shows the slightly swollen, upper part of the hypocotyl, two secondary roots, and an apical bud, covered by two small scale-leaves (Fig. 28). The secondary roots, a part of the hypocotyl and the bud thus constitute the early perennial habit of the species.

III.—THE HYPOCOTYL.

The tuber in *Collinsonia Canadensis* L., in *Arisaema triphyllum* (L.) Schott, and the creeping, thick rhizome in *Sanguinaria Canadensis* L. and *Dioscorea villosa* L. may be traced already at the seedling-stage. Characteristic of *Collinsonia* is the germination with the cotyledons hypogeic; in this respect it agrees with *Melittis* (Irmisch), but these two genera are the only *Labiatae,* known so far, in which the cotyledons are hypogeic. In *Collinsonia* the hypocotyl is at first not thicker than the epicotyl, but towards the end of the first season it begins to increase in thickness so as to form a round, tuberous body (Fig, 21), with the primary root soon fading away. The primary root is very slender, and becomes replaced by two long, secondary roots, developed beneath the cotyledons, but in some distance from these. Already during the first season the seedling thus shows a tuberous stem, and the cotyledonary buds are readily visible with the base distinctly swollen; a small, vegetative shoot appears in the first season, but the first stage of hibernation is only represented by the tuber with the buds and the secondary roots. The first rejuvenation consists in the cotyledonary buds developing into aerial, mostly vegetative shoots, of which the basal, scale leaves subtend buds of the same structure and growth as the cotyledonary. In the mature plant the tuber shows many knotty protuberances caused by the shortness of the basal stem-internodes and their very considerable growth in thickness. Mature tubers vary much in size; the largest we have found measured seven cm. in length and one and a half cm. in width; they are always provided with numerous strong, though slender secondary roots, which push out from the lower face and the sides of the tuber. Mostly a single, aerial shoot develops from each tuber, but the plant is polycarpous. *Scrophularia nodosa* L. shows a similar structure according to Wydler, but in this plant the epicotyl takes also part in the formation of the tuber.

In *Arisaema triphyllum* (Fig. 22) the primary root is quite long while the plumule is still enclosed by the sheath of the cotyledon, and the hypocotyl is also distinct as shown

18
Hyp.
R.
r.
19
Cot.
Hyp.
R.
20
Hyp.
R.
22
R.
21
Cot.
Hyp.
r.
R.
r.
26
Cot.
Hyp.
R.
27
B.3
l.2
L.
B'
B.2
l.1
Hyp.
Cot.
R.
24
25
St.
L.
Hyp.
R.
23

PLATE 3.

PLATE 3.

Figure 18. Same species. An older seedling, showing the withered primary root and hypocotyl; letters as above. 3 × natural size.

Figure 19. *Sanguinaria Canadensis* L. Germination; letters as above; natural size.

Figure 20. Same species. Rejuvenation. A plant in its second year; letters as above natural size.

Figure 21. *Collinsonia Canadensis* L. A seedling at the autumnal stage. Cot. = the cotyledonary buds; other letters as above; natural size.

Figure 22. *Arisaema triphyllum* (L) Schott. Germination. Longitudinal section of a seedling with the cotyledon enclosed by the seed; R. = the primary root; 4 × natural size.

Figure 23. Same species. A seedling at the end of the first season, showing the first green leaf, the tuberous hypocotyl (Hyp.) and four secondary roots; 4 × natural size.

Figure 24. Same species. Rejuvenation; a specimen in its third year, showing the tuberous rhizome with four secondary roots, three membranaceous, scale-like leaves, and one aerial, green; 4 × natural size.

Figure 25. *Dioscorea villosa* L. A young plant in its second year; L = the withered petiole of the first year; St. = the base of the first aerial stem (St.); natural size.

Figure 26. Same species. Germination. The seed has been removed to show the cotyledon; letters as above; natural size.

Figure 27. Same species. Schematic drawing of a seedling at the close of the first season; for explanation see text; enlarged.

in this figure, which represents a longitudinal section of the seedling. But so soon as the first green leaf has unfolded its ovate blade, the cotyledon and the primary root wither and drop off; at this stage the hypocotyl has developed into a round tuber, with four secondary roots (Fig. 23). During the first season no other leaves develop, and it is thus characteristic of *Arisaema*, and also of *Pinellia*, that no scale-leaves precede the assimilating, green one as in the case of *Arum* (Irmisch.) At the first stage of rejuvenation the tuber is still small, but the foliage consists now of two long, tubular, membranaceous leaves preceding a green with the blade ternately divided. During the second summer, however, the tuber increases in size, in length especially, thus the secondary rejuvenation shows us (Fig. 24) a tuber consist-

ing of two swollen internodes, the basal being the hypocotyl, and with a new set of secondary roots around the apex of the tuber, which is now terminated by a purely vegetative shoot with three tubular, and one green leaf of the typical shape, ternately divided. The ramification of the shoot is monopodial until the first inflorescence appears, and at this stage there are generally two green leaves with ample blades; of these the basal subtends a bud, which continues the growth of the individual; some few additional buds may also be observed upon the tuber, and these are developed in the axils of the tubular leaves from the preceding season, and most frequently they remain dormant.

Sanguinaria Canadensis has a relatively long, stout, horizontally creeping rhizome, originating from the hypocotyl and the plumule. The cotyledons are hypogeic, the hypocotyl erect, and somewhat swollen; the primary root is slender, and often accompanied by a secondary of about the same length. Only one green leaf appears during the first season (Fig. 19), and the blade is entire, not palmately lobed as in the leaves of the mature plant. At the first rejuvenation the primary root still persists, and the hypocotyl has now developed into an oblong tuber with several scattered secondary roots. The foliage now consists of five scale leaves, exactly alternate, which surround the base of a long-petiolate, green leaf, with the blade broadly cordate or reniform. The shoot remains purely vegetative for several years, and only one green leaf and some few scale-like are developed each year. In mature specimens the single flower is subtended by a large, more or less deeply lobed leaf, (Fig. 41.), while the lateral shoots of the rhizome begin with the same type of leaf as observed in the seedlings.

A much faster development of a typical rhizome with several lateral buds and secondary roots is exhibited by *Dioscorea villosa*. At the first stage of the germination (Fig. 26) the primary root is not very long, and only sparingly branched, the hypocotyl is erect, and two secondary roots proceed from its basal portion. The cotyledon remains enclosed within the seed, and only one green leaf appears during the first season. In the course of the first summer the hypocotyl increases considerably in thickness, besides that the

plumule develops several internodes with scale-leaves. The first hibernation is thus marked by a typical small rhizome showing the structure as follows (Fig. 27): The primary and the two secondary roots persist; the hypocotyl is quite thick, but the seed with the cotyledon has fallen off. The green leaf has withered, and a small bud is now visible in its axil (B^1); the primary axis shows now three distinct, thick internodes with scale-leaves of which the basal (I^1) subtends a bud (B^2), partly fused together with the internode above. The apex of the axis bears a scale-like, barren leaf and a terminal bud (B^3); a secondary root proceeds from the base of each of the scale-leaves. In other words the somewhat complicated branching of the rhizome is already shown at the first stage of hibernation. The first rejuvenation (Fig. 25) shows the primary root in a withered condition, while the rhizome has now increased in length, occupying a horizontal position, and provided with several secondary roots. The withered petiole of the first green leaf is still attached to the rhizome, and a short stem has developed with a single green leaf and a terminal bud, which does not grow any further, however. If we compare the stage of rejuvenation with that of hibernation (Fig. 27), the function of the buds may be readily understood. The bud B^1 develops as a small tuber, which remains subterranean, forming sometimes a lateral branch of the rhizome, or it stays dormant. The terminal bud B^3, on the other hand develops into an aerial shoot, while B^2 stays under ground, continuing the horizontal growth of the rhizome. This structure thus illustrates a typical sympodium, and at a remarkably early stage of the development of the plant: the first rejuvenation. When the rhizome grows older, and the first floral shoot appears the position of the various buds becomes obscured completely on account of the somewhat irregular growth of the internodes, resulting in a partial displacement of the buds.

While thus the hypocotyl is the first part of the plant to increase in thickness in the species mentioned above, the further growth of the primary axis results in the formation of very different types of subterranean stems: roundish tubers or long, horizontally creeping rhizomes; but a feature common to these plants is the early fading of the primary root,

and a corresponding early development of a secondary root-system. Tubers of the same primary structure are also characteristic of *Cyclamen, Umbilicus, Eranthis,* and certain species of *Corydalis.*

IV.—BUDS IN THE AXILS OF THE COTYLEDONS.

This structure is very frequent and characteristic of several families, seldom of certain species only. The further development of these buds is different however. They may grow out as tuberous stems (*Triadenum, Cunila*), as long, slender stolons terminated by tubers (*Labiatae*) or as aerial shoots, sometimes replacing the primary (many *Leguminosae.*) In *Cunila Mariana* the first hibernating stage (Fig. 29) shows one of the cotyledonary buds developed into an ascending, subterranean shoot with thick internodes and small, opposite, membranaceous leaves; in mature specimens several shoots of this structure appear at the base of the stem, and during the following spring they grow out as aerial flower-bearing shoots. A very characteristic structure is exhibited by *Triadenum Virginicum.* The seedling has epigeic cotyledons, and a short hypocotyl; it reaches the flowering stage commonly in the first summer, ripening the seeds late in the fall, while the main axis dies off during the winter. Nevertheless the plant is perennial, for during the flowering period the basal part of the stem has begun to ramify, showing one to two pairs of horizontal branches, stolons, developed from the axils of the cotyledons and the subsequent pair of leaves. The former, the cotyledonary, have thick, short internodes and small scale-like, membranaceous leaves; they ramify freely (Fig. 30), but are rootless for several months; their color varies from crimson to yellowish brown. The other stolons, which develop from the axils of the leaves above, are slender, and as a rule they do not ramify. The first rejuvenation is marked by the stolons producing aerial, vegetative or floral shoots, and that secondary roots have now developed at the nodes of the stolons, or more correctly just above the nodes. While the aerial shoots die off during the fall, the remaining part of the tuberous stolon is able to continue its ramification for at least another year.

We have thus in *Cunila* a perennial herb with a pseudorhizome, and of which the rejuvenation is effected by means

of the lateral shoots with the basal internodes fleshy, and covered with scale-leaves, as shown at the stage of hibernation. In *Triadenum*, on the other hand, the mother plant persists only for one or two years, while the stolons may continue their growth for a longer period, branching and producing many aerial shoots (Fig. 31). *Glaux maritima* L. shows a very singular structure according to Buchenau. The cotyledons are epigeic, and the primary shoot does not ramify; it dies down to the ground during the first season leaving only a cotyledonary bud provided with a storage-root to hibernate. The first rejuvenation thus depends upon the development of this bud into a small, aerial, leafy shoot, rooting at the nodes; horizontally creeping stolons develop from the basal leaves of this shoot, and the leaves of the stolons subtend buds for the next year. These buds are also provided with storage roots, and likewise the cotyledonary, they are the only parts of the plant that hibernate, the leafy shoots as well as the stolons themselves dying off at the close of the first season.

The cotyledonary bud in Glaux thus persists as a bud with a large root during the hibernation, and constitutes the only part of the seedling left active at that stage.

In many of the other herbs, of which the cotyledons subtend buds, these may develop into runners or stolons, the latter remaining slender in their entire length or becoming terminated by tubers or bulbs. In such plants the hibernation is often marked by the persisting stolon, or by its apex alone, when terminated by a tuber or bulb. In *Lycopus Virginicus* L. the stolons are tuberiferous, but slender in *L. Europaeus* L.; in *Scutellaria lateriflora* L., *S. galericulata* L., *S. Californica* Gr. the stolons are slender, but tuberiferous in *S. parvula* Rich., *S. tuberosa* Benth. etc. Many other examples (European) are mentioned by Irmisch, Warming and some other authors. In these plants the rejuvenation thus depends upon the formation of an aerial shoot from the apex of the stolon.

A stronger vitality of the primary shoot, or let us say the seedling, is exhibited by some plants, in which the cotyledonary buds develop into runners. For instance, *Glechoma hederacea* as described by Irmisch does not only develop

runners of considerable length, but the primary shoot becomes also prostrate, and runners are developed from the axils of many of the cauline leaves, of the same structure as the cotyledonary.

There is also a number of herbs, but of erect habit, in which the cotyledonary buds directly develop into aerial shoots with the basal internodes persisting, and contributing to the formation of a pseudo-rhizome. This type is apparently common in the *Leguminosae*, and not infrequently the cotyledonary shoots replace the primary. In *Baptisia tinctoria* R. Br., for instance, (Fig. 32), the seedling shows in the first season the epigeic, cotyledons borne upon an erect, slen-

PLATE 4.

Figure 28. *Cimicifuga Canadensis* Nutt. The first hibernation, showing the apical bud, the partly faded hypocotyl and primary root; two strong secondary roots have developed from the primary shoot; 2 × natural size.

Figure 29. *Cunila Mariana* L. Hibernation; a tuberous, subterranean shoot has developed from the axil of one of the cotyledons; St. = base of the aerial shoot; 5 × natural size.

Figure 30. *Triadenum Virginicum* (L.) Rafin. Hibernation. Tuberous, cotyledonary shoots have been developed: R = the primary root; natural size.

Figure 31. Same species. Rejuvenation. A branch of the rhizome developing into an aerial shoot; the secondary roots proceed from the axils of the scale-like leaves, and a small stolon is about to develop; two-thirds of the natural size.

Figure 32. *Baptisia tinctoria* R. Br. Rejuvenation. A plant in its second year, showing the withered, primary shoot (St.), and two cotyledonary shoots, the hypocotyl (Hyp.), and the persisting, primary root (R.) with tubercles; natural size.

Figure 33. *Dentaria laciniata* Muehl. Germination. The plumule has developed into a small tuber, bearing a green leaf; letters as above; 3 × natural size.

Figure 34. *Dicentra Cucullaria* (L.) Bernh. Rejuvenation. A young plant developed from a bud in the axil of a fleshy, scale-like leaf of the rhizome; 3 × natural size.

Figure 35. *Viola papilionacea* Pursh. Rejuvenation. The rhizome of a plant in its second year with the primary root still visible; 2 × natural size.

Figure 36. *Oxalis violacea* L. Rejuvenation. A bulb with two young stolons and a large storage-root; natural size.

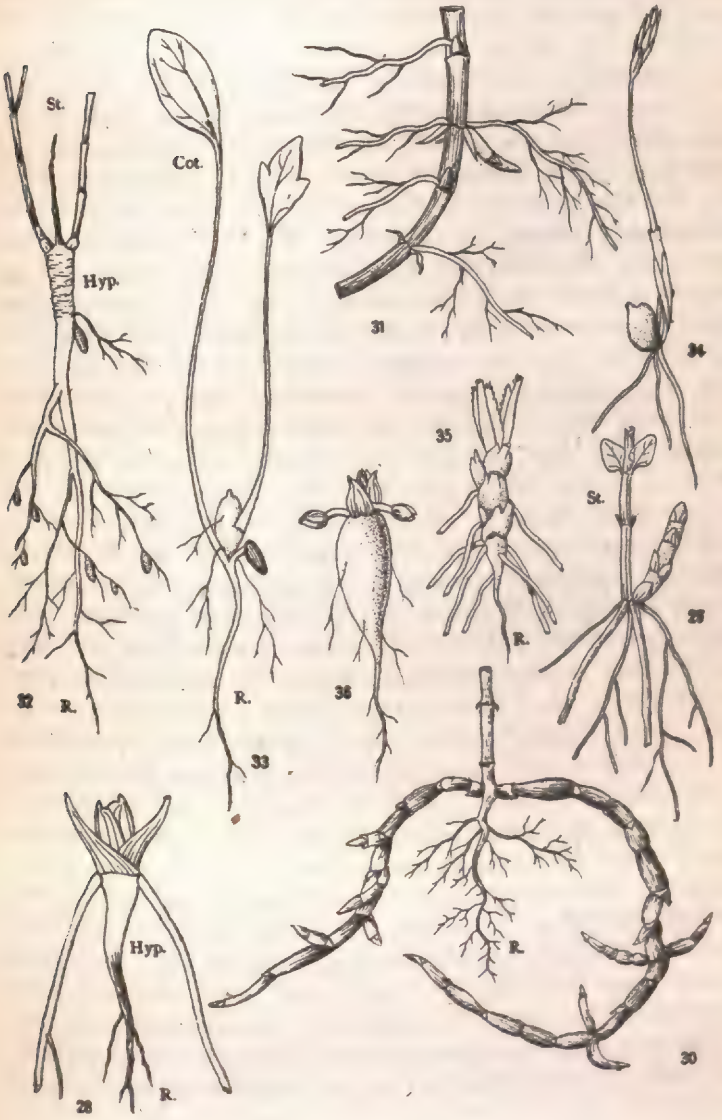


PLATE 4.

der hypocotyl, and the primary root is quite long, and bears several tubercles; the plumule develops into an erect, leafy shoot, but dies off at the end of the first season, leaving only the hypocotyl, the cotyledonary buds and the root still active. Meanwhile the hypocotyl and the primary root begin to increase in thickness, and become contractile, drawing the buds down into the ground. By the first rejuvenation the buds grow out as vegetative shoots, thus replacing the primary, and the hypocotyl as well as the root continue to grow, increasing gradually in thickness. So far as we have observed, the first flowering does not take place until four or five years after the germination. The first rejuvenation thus indicates the future habit of the plant with regard to the rhizome. In fully matured specimens the rhizome consists of the hypocotyl and the persisting bases of the aerial shoots with their small tubular, membranaceous leaves subtending buds. The primary root persists so long as the plant lives, and strong, thick secondary roots develop from the base of the pseudo-rhizome. It is a type of rhizome, which is very frequent among the *Papilionaceae* with epigeic cotyledons. As mentioned above a corresponding growth recurs in certain species of *Melilotus*, but in these the individual persists only for two years; in *Strophostyles* we have seen that the duration is one year longer owing to the primary root-system remaining active and producing shoots in the third year. *Chenopodium ambrosioides* L. germinates in the same manner as *Baptisia*, but the plumule develops into a tall, flower-bearing stem during the first season; the hibernation and rejuvenation correspond with *Baptisia*, and the subterranean stem represents a pseudo-rhizome. In *Phryma leptostachya* L. the primary root dies off during the first season, becoming replaced by several strong, secondary roots; the cotyledonary buds remain dormant until the succeeding spring, when they develop into erect, aerial shoots, purely vegetative. The basal internodes of these persist, increase in thickness, and by the continuous development of buds in the axils of the basal leaves a pseudo-rhizome becomes formed.

The occurrence of cotyledonary buds in the Monocotyledones appears to be very rare. In *Maianthemum bifolium*

(L.) F. W. Schmidt Raunkiaer observed a typical stolon developed from the axil of the cotyledon (fide Warming 1918, p. 320), and in *Similax rotundifolia* L. we have also observed a cotyledonary bud, which developed into a tuber of three internodes, or into a vegetative shoot, but both with the first leaf representing an adorsed prophyllon.

The function of the cotyledonary buds to produce shoots, and these being of great importance to the vegetative reproduction, is as we have seen, sometimes connected with the very early death of the mother-plant, the seedling; the seedling may even die without having reached the flowering stage. The multiplication of the individual thus embodies the destruction of the mother-shoot, nevertheless such plants are referred to the group: perennials. It would be difficult to classify them in any other manner, even if the new, independent individuals are subject to the same conditions as the original, the seedling. In certain typically annual plants the cotyledonary buds sometimes remain dormant until late in the summer or the fall, when they suddenly grow out as leafy shoots, but aerial, not subterranean; they may hibernate, and produce flowering stems in the succeeding spring, without becoming detached from the mother-plant: the hypocotyl and the root. In other words, these annuals follow, so to speak, the example of *Melilotus* and *Strophostyles* by their vegetative reproduction being above ground. In no instances have we observed such annuals tending to become perennial by means of subterranean structures.

Warming, in his very instructive work on shoot-structure (1884), expressed the opinion that perennial species, which are closely related to annuals, are often stoloniferous, the cotyledonary buds developing into subterranean shoots; he mentions as an example the perennial *Oxalis stricta* L., as compared with the annual *O. corniculata* L. According to our experience there are too many exceptions for considering this suggestion applicable in general. Some few examples may be mentioned. *Arabis lyrata* L. varies from annual to biennial or even perennial; the last form has a persistent primary root, crowned by many rosettes of leaves, subtending the floral shoots. This species as well as *A. dentata* T. et G. belongs to the section *Sisymbrina* Wats., but the habit of *A. dentata*

is quite different; it is a perennial, but has only one rosette of leaves, subtending the ascending flowering stems, and the structure of the shoot is monopodial. In the section *Kneiffia* of *Oenothera* we have the annual, or occasionally biennial, *O. linifolia* Nutt., while all the other species of the section are perennial, and none being stoloniferous. Furthermore the nearest allies of the annual *Polygonum Hydropiper* L.: *P. acre* H. B. K., *P. setaceum* Baldw., and *P. hydropiperoides* Michx., are perennial, but only by the stems being decumbent, and rooting. The annual *Erigeron annuus* (L.) Pers. and *E. strigosus* Muehl. as compared with the perennial *E. bellidifolius* Muehl. with its leafy, prostrate shoots are also a good illustration of a perennial habit being effected by aerial structures instead of by subterranean "stolons," although the species allied are annuals.

V.—THE PLUMULE.

It seems to be very seldom that the plumule itself indicates the future perennial habit; such is the case, however, of *Dentaria laciniata* (Fig. 33.) There is no hypocotyl, and only one of the cotyledons appears above ground, the other remaining enclosed within the seed. As shown in the figure the plumule has developed into a small, oblong, erect tuber, bearing a long-petioled, green leaf, the first succeeding the cotyledons. Very thin, secondary roots become developed from the tuber, and the primary root fades away during the first season. The tuber shows exactly the shape of the future rhizome, that is to say of one year's growth, and it gradually changes its direction from vertical to horizontal. It is interesting to notice that in the European *D. bulbifera* L. the plumule develops in the shape of a bulblet, resembling the bulblets borne in the axils of the upper stem-leaves. As described by Warming the rhizome of *D. bulbifera* shows the unusual structure of the scale leaves being very thick, rich in nutritive substances, as are also the internodes to some extent. The same structure recurs in our *D. diphylla* Michx., but we have not had the opportunity to study the seedling-stage of this species.

Viola papilionacea Pursh (Fig. 35), and several of the other acaulescent species show a similar structure of the rhizome and it begins already at the seedling-stage. The hypocotyl increases in thickness, and the plumule develops several green leaves, which wither during the summer, but leaving the bases of the petioles and stipules intact; as a matter of fact the primary axis represents at the first hibernation a small, erect rhizome with the swollen bases of the leaves. These persistent bases of the petioles and stipules contain large deposits of starch, as do also the short internodes. The mature rhizomes of these *Violae* are horizontal, and they resemble very much those of *Dentaria bulbifera* and *D. diphylla*, thus representing a combination of a bulb and a rhizome. In *Viola bulbosa* Maxim. from the Himalayas the subterranean stem is described as a true bulb.

The peculiar seedling of *Podophyllum peltatum* L. may be mentioned here. The cotyledons have long petioles, which are united to their full length so as to form a cylindrical, hollow tube. The very small plumule is located at the base of this tube, and does not grow any further during the first season. The primary root is long and branches freely, but no hypocotyl is developed. The plumule and the root hibernate, the cotyledons having withered during the fall. At the first rejuvenation we notice that the plumule has developed into an exceedingly short axis (vertical), bearing three membranaceous, scale-like, and one aerial, green leaf with the blade peltate. This structure is also to be seen, when the plant is in its third year, besides that two secondary roots have developed from the nodi of the previous year's growth. It is not until the plant has reached an age of four or five years that the direction of the rhizome becomes changed from vertical to horizontal. This type of germination, with the plumule inclosed in the tubular sheath of the petioles is known also from several other plants. Among the *Berberideae* themselves, *Leontice Altaica* and *L. vesicaria* show a similar structure according to Bernhardi; a larger number of cases have been observed in the *Ranunculaceae* viz., species of *Anemone*, *Ranunculus*, *Delphinium*, *Aconitum*, and *Eranthis;* in the *Umbelliferae*, viz. species of *Ferulago*, *Prangos*, *Smyrnium*, *Bunium*, and *Chaerophyllum bulbosum;*

furthermore in *Megarrhiza Californica, Rheum Moorcroftianum, Polygonum Bistorta, P. viviparum,* and *Dodecatheon Meadia.* With the exceptions, however, of *Eranthis, Aconitum* and *Ranunculus* the plumule develops during the first year, breaking through the base of the tube.

Finally in *Dicentra Cucullaria* (L.) Bernh. the seedling-stage having been described by Irmisch, only one of the cotyledons is developed; this has a small, tripartite blade, and the swollen base of the petiole surrounds the plumule with a few membranaceous scale-leaves. During the first season the cotyledon withers, and the hibernating stage becomes thus represented by a small, tuberous body, the base of the petiole, and the minute bud. At the time of rejuvenation (Fig. 34) a green leaf appears, surrounded at the base by the membranaceous leaves, and with the tuber still attached. In other words the first rejuvenation gives us an exact illustration, though in a smaller scale, of the habit of the mature plant. The subterranean stem with its foliage represents a structure intermediate between a bulb and a rhizome. It is of a globular or ovoid shape, and consists of a much ramified axis with the branches very short and densely covered by fleshy, scale-leaves of a light rose color; these scale-leaves show on their ventral face a small cavity enclosing a minute bud, surrounded by thin, membranaceous scales. In the course of the summer, when all the aerial leaves and floral stems have withered, the small, fleshy leaves drop off, and with their buds enclosed they develop new individuals in the succeeding spring. The rhizome, however, bears also some large buds, terminating the axis, which at the time of rejuvenation give rise to several green leaves and a terminal flowering stem. We have thus in *Dentaria, Viola* and *Dicentra* some examples of a very rare structure, where a tuber, a bulb or a bulb-like rhizome appear as primary structures, owing their development to the plumule or even to the cotyledon alone as in *Dicentra.*

VI.—BUDS UPON THE LATERAL ROOTS.

Root-shoots are known from several herbs, but we know of only one genus, *Rhexia*, where they appear already at the seedling stage. In *Rhexia Virginica* L. the seedling does not reach the flowering stage, and dies off in the course of the first summer, leaving only one or two lateral roots still active. These roots increase in thickness, forming small tuberous bodies, which hibernate, and produce aerial shoots in the succeeding spring. *Rhexia Mariana* L. multiplies in the same manner, but the roots remain slender, increasing considerably in length, however, and produce many aerial shoots. The simplest type of hibernation, is thus exhibited by *Rhexia*: a lateral root with some buds.

These are the principal methods by which the perennial habit becomes effected, to be traced already from the seedling-stage. The first hibernation and rejuvenation frequently indicate, how the final habit of the plant will be, and especially with regard to the subterranean organs. The secondary root system and the cotyledonary buds play a rôle of great importance in the Dicotyledones. But even if this root-system substitutes the primary root completely, and at a very early stage in the Monocotyledones, the structure of the primary shoot seldom becomes influenced in these so as to show any particular modification; the final habit of the Monocotyledones is very seldom indicated at the seedling stage.

By examining these six types of hibernation and rejuvenation, described in the preceding, it is interesting to notice how the same type may be exemplified by very different families, and that species, otherwise closely related, may be very distinct in this respect. As a matter of fact the seedling stage alone may, in some instances, be quite different: germination with only one cotyledon; the cotyledons being hypo- or epigeic; the primary root being a storage-root from the very beginning; the hypocotyl being well represented or not developed at all, etc. These various structures, however, are still more conspicuous, when we examine the mature plants at their stage of hibernation and rejuvenation. Nevertheless the rejuvenation will prove to some extent, to be a repeti-

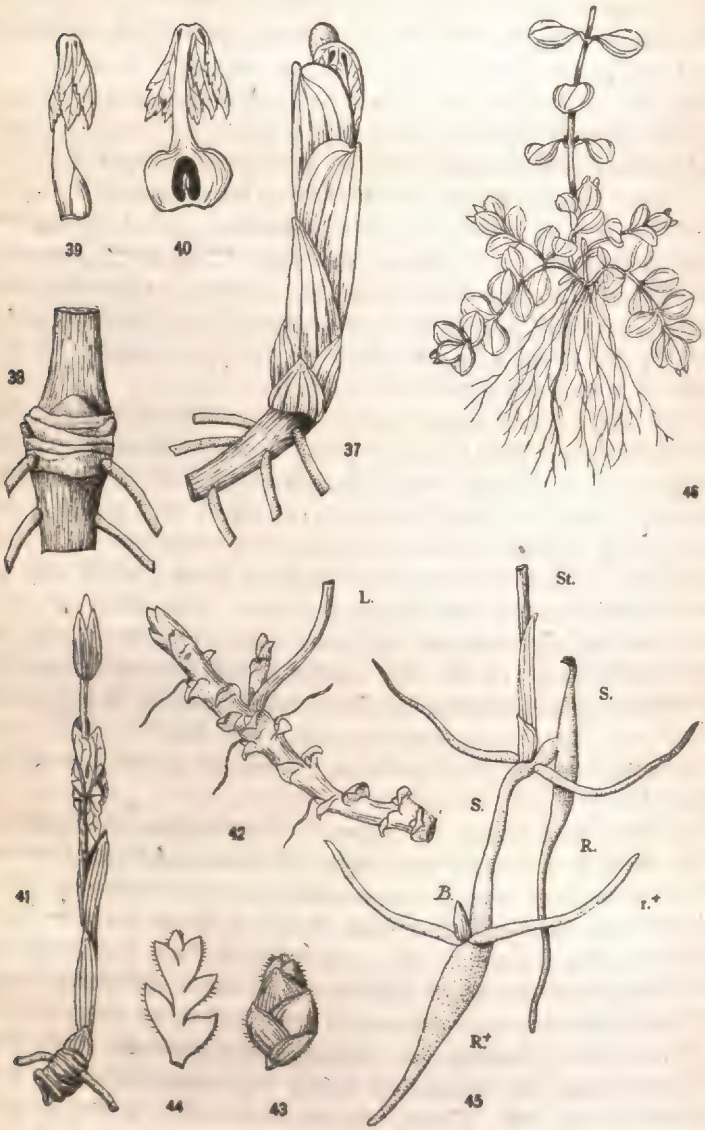


PLATE 5.

PLATE 5.

Figure 37. *Podophyllum peltatum* L. Rejuvenation. Apex of the rhizome of a mature specimen, showing the scale-leaves surrounding the flower-bearing stem; two thirds of the natural size.

Figure 38. Same species. Apex of the rhizome of a mature specimen, seen from below; the scale-leaves have been removed to show the buds; the largest bud at the base of the stem is terminal, but remains dormant. One of the two swollen buds will continue the growth of the rhizome; two thirds of the natural size.

Figure 39. Same species. Rejuvenation; one of the two green leaves; enlarged.

Figure 40. Same leaf with the base laid open to show the other green leaf enlarged.

Figure 41. *Sanguinaria Canadensis* L. Rejuvenation, showing the erect flowerbud, the green leaf, and the scale-leaves, besides the apex of the rhizome; two thirds of the natural size.

Figure 42. *Dentaria diphylla* Michx. Rejuvenation; The rhizome with a green leaf (L.) subtending a branch; two thirds of the natural size.

Figure 43. *Lithophragma tenella* Nutt.; one of the bulbs from the base of the stem; enlarged.

Figure 44. Same bulb, longitudinal section; enlarged.

Figure 45. *Platanthera clavellata* Michx. Hibernation. St. = the base of the floral shoot with the old rhizome (S.) and roots (R. and r.) S*, R* and r* are the corresponding rhizome and roots, B = the hibernating bud; two thirds of the natural size.

Figure 46. *Hypericum mutilum* L. Base of a mature specimen with several aerial shoots to hibernate; natural size.

tion of the younger stage, the advanced growth of the seedling preparing for the first hibernation. But in the mature plants the development of floral shoots and the necessary increase of foliage require some modifications to take place in the subterranean and aerial structures. We shall now describe some rhizomes of more or less complicated composition, ramified or of a very condensed growth; tubers and bulbs; stolons and runners; further increase in the root-system, and the development of buds of different form and variously situated.

The term "rhizome" is often applied to any subterranean stem including stolons, etc., and it is really a difficult matter to give any precise definition of a structure so polymorphous as the subterranean stem, even if we exclude stolons and

similar shoots, which do not belong to the subterranean stem s. s. It is often necessary to have studied the germination, and naturally the further growth of the plumule during the first one or two years in order to ascertain the exact nature of certain subterranean stems, whether they represent the primary axis or axes of secondary order; the axes of secondary order, cotyledonary shoots for instance, are stolons, when subterranean, runners, when aerial. The rhizome itself, depends undoubtedly, in most cases, upon the gradual development of the plumule into a subterranean, horizontal or vertical stem with sympodial or monopodial ramification. But the question of characterizing the "rhizome" in a comprehensive manner so as to include all the types existing, is hardly possible. Some few years ago (1918) the suggestion was made by Warming to restrict the term rhizome to "horizontal (plagiotropous) subterranean stems with short, generally thick internodes, rich in nutritive matters, and frequently with only a few, thin roots" (*Anemone nemorosa, Polygonatum, Scrophularia nodosa, Dentaria bulbifera*). On the other hand, a new term "rhizode," suggested by the same author, should be used for "horizontal subterranean stems, which are not thick like the rhizomes, but thin and with the internodes stretched, thus resembling stolons." (*Hippuris vulgaris, Paris, Carex arenaria, Scripus lacuster*, etc.) Furthermore the term "mesocormus" should apply to the vertical subterranean stems of *Primula, Plantago major, Sedum telephium* and numerous others. Regarding the axillary shoots Warming (l.c.) proposed the term "stolons" for the aerial, and "suboles" for the subterranean. The term "mesocormus" became substituted for "pseudo-rhizome" (Hj. Nilsson), although some of the examples mentioned: *Primula* and *Plantago major* are by Nilsson included under "rhizome s.s." The material studied by Warming, was principally of Scandinavian origin, a fact that might explain the somewhat narrow definition of "rhizome," besides the misleading "rhizode." As indicated above, it would be a very difficult matter to define "rhizome" as a typical and constant stem-structure, and the segregation of the more slender forms as "rhizodes" would not seem feasible, when we deal with North American plants. For instance the horizontal, subterranean stem, developed

from the plumule itself in *Podophyllum* could not be included under "rhizome," since it consists of a series of slender, stretched internodes alternating with short, and thickened, besides that the roots are relatively thick, and strong. Moreover in *Iris cristata* and its allies, in *Medeola* and several others the structure is not identical throughout. The subterranean stem of *Aplectrum* with tubers alternating with long, slender internodes, could not possibly be termed a rhizome according to the definition given by Warming. Nevertheless these and several other types of subterranean stems do represent rhizomes, and consequently we prefer to consider them as such. Rhizomes are furthermore the subterranean stems of *Tipularia*, of *Corallorrhiza*,, some of the acaulescent species of *Viola*, *Dentaria* (all the species), as well as the vertical of *Trillium*, *Uvularia*, *Plantago*, beside the descending in *Orchis*, *Platanthera*, etc. The term pseudo-rhizome is, according to our opinion, so well defined by Hj. Nilsson, that we see no reason why it should be changed to "mesocormus." The aerial, axillary, prostrate stems have since long been called runners, whether they bear leaves (*Glechoma*, *Antennaria*) or are leafless (*Saxifraga flagellaris*), but terminated by a rosette of leaves. The corresponding, but subterranean are called "stolons," whether slender in their entire length (*Oakesia*, *Viola primulifolia*), or terminated by tubers (many *Labiatae*, *Trientalis*, *Cynthia*, *Cyperus phymatodes* etc.), or bulbs (*Erythronium*, *Claytonia Chamissonis*, *Oxalis violacea*, etc.) Finally we wish to point out that there are some types of rhizomes, which must be characterized a little more precisely than simply as rhizomes, for instance the coralloid, profusely branched in *Corallorrhiza*, and the similar, but additional in *Aplectrum;* the shoots in *Lithophragma* (Figs. 43, 44) resemble bulbs, but the fleshy scales are borne upon a distinct horizontal axis, a structure that occasionally recurs in *Lilium superbum*. In *Hydrophyllum Canadense*, as already described by Alexander Braun, the horizontal rhizome bears several fleshy scales, preceding the aerial leaves, thus representing a transition between bulb and rhizome; the acaulescent *Viola papilionacea* and its allies, besides *Dentaria diphylla* (Fig. 42) possess similar bulb-like rhizomes. Some certain rhizomes are very much

ramified as for instance in *Comandra,* thus the branches may be mistaken for stolons, but it is always characteristic of stolons, that their external structure, length and thickness of internodes, is quite distinct from that of the axis that bears them, readily to be seen in *Triadenum,* many *Labiatae, Claytonia Chamissonis,* etc., in which the stolons are more or less tuberous, or very slender.

In passing to describe the hibernation and rejuvenation as exhibited by the mature plants, we do not attempt to suggest any classification of the various types, nor will it be possible to follow the same arrangement as we have done with reference to the seedlings and their subsequent growth during the first and second year. For even if the youngest stages of many plants may indicate the future habit, the mature root-system as well as the stems under ground show many modifications, naturally to be expected. By studying the seedling-stage we have learned how the perennial habit is effected, the principal means being the root-system, the hypocotyl, the plumule and the cotyledonary buds. In the mature plants, however, the subterranean organs have become developed still further, not only for securing the perennial habit in the manner of vegetative reproduction, but in many cases, also for securing the distribution over a larger area, not speaking of the most important, the storing of nutritive matters. Of these structures the horizontally creeping rhizomes represent undoubtedly the most important. Their development is relatively slow; they do not produce floral shoots before several years after the germination, but they may persist for many years in an active condition. In these particular points the rhizomes thus differ from the stolons.

A very interesting type of rhizome is represented by *Podophyllum peltatum* L. We have seen, that the plumule of the seedling hibernates as a bud, and that the first stage of rejuvenation shows three scale-leaves preceding an aerial with petiole and leaf-blade. The beginning of the rhizome consists of a few, very short internodes, forming an erect axis, but when the plant has reached the age of four or five years, a lateral bud appears and grows out as a horizontal shoot. The mature rhizome may be of a very considerable

length representing the growth of several years, and the growth of each year depends upon the development of a short, erect shoot of several internodes, and of a horizontal with the internodes long, and not so thick as those of the former. At the apex of the horizontal branch is a large bud, which hibernates. If we examine this bud, while still subterranean and perfectly closed, we find inside the scale-leaves a small, but very distinct leaf with a pellate blade (Fig. 39), and with the sheathing petiole surrounding another leaf of same shape, but much smaller (Fig. 40). These two leaves, although not developed at exactly the same time, will become the foliage of the flowering stem, the two green leaves held above the single flower. The stage of rejuvenation is thus marked by the opening of the large, frontal bud (Fig. 37), besides that a bud soon becomes visible in the axil of one of the scale-leaves, which in the course of the summer grows out as a horizontal shoot, in the same direction as the main rhizome itself. These two very conspicuous parts of the rhizome thus constitute the growth of one season, and they show exactly the same minor structure as all the posterior from the years previous. The ramification of the rhizome is very complicated, and we have described this in the Botanical Gazette (1899). We shall only mention in this place, that the erect shoot is terminated by a dormant, vegetative bud, while the flowering stem is lateral, being developed in the axil of the innermost scale-leaf; consequently the erect shoot represents a monopodium, while, on the other hand, the continuation of the entire rhizome by means of the axillary bud (Fig. 38) makes the ramification sympodial. Such alternations of monopodia and sympodia in the same rhizome are not infrequent; they are exceedingly well exemplified by *Calypso, Tipularia, Aplectrum* and others. The rhizome branches frequently, and the branches show exactly the same external structure as the main rhizome, which we have seen originated from the plumule itself. Regarding the root-system this is well represented in *Podophyllum* by several strong, ramified roots proceeding from the short, erect internodes, just beneath the floral shoot; they are storage-roots with the cortex and pith representing large tissues with deposits of starch; the rhizome contains also starch in

abundance. Finally with regard to the flower-bud this is erect from the very earliest stage of the rejuvenation, while, as we remember, a nutation is characteristic of the Dicotyledones. In this respect *Podophyllum* agrees with *Caulophyllum, Jeffersonia* and *Sanguinaria.*

(To Be Continued.)

The American Midland Naturalist

PUBLISHED BI-MONTHLY BY THE UNIVERSITY
OF NOTRE DAME, NOTRE DAME, INDIANA

Vol. IX. JULY, 1925. No. 10.

HIBERNATION AND REJUVENATION, EXEMPLIFIED BY NORTH AMERICAN HERBS.

THEO. HOLM.

(Continued from the May Issue.)

A thick horizontally creeping rhizome is also exhibited by *Sanguinaria,* but all the internodes are very short, and of the same thickness throughout; lateral branches are frequently to be observed, and there are many roots, all of the nutritive type; on the other hand the cortex and the pith of the rhizome contain large deposits of starch. At the stage of rejuvenation in the early spring the erect flower-bud is the first to appear, with the blade of the single leaf wrapped around the scape (fig. 41); the leaf does not attain its full size until the plant is out of bloom, and it persists until the close of the summer. In *Dentaria,* a very small genus, but with rhizomes of several distinct types, we have a long, horizontally creeping rhizome in *D. diphylla* (Fig. 42); the internodes are thick, and the scale-leaves fleshy, each subtending a bud with a slender root proceeding from its base. Only a very few of these buds grow out in the same year, and the lateral shoot then begins with a scale-leaf, or the bud develops directly into a flower-bearing stem. A very different structure is shown by *Dentaria laciniata* and *D. heterophylla,* in which the rhizomes represent a horizontal chain of long tubers, each representing the growth of one season; in these the subterranean foliage is only of very thin scale-leaves, barely visible. Only a single green leaf is developed, though not every year, and the flower-bearing stem, only one from the same tuber, is axillary; the roots

are very thin, and mostly in pairs from the axils of the scale-leaves. In *Dentaria tenella* the rhizome resembles that of *D. laciniata*, but is densely pubescent; in this species we notice the very rare case of small tubers becoming developed from the subterranean part of the long petioles. This type of growth, where the aerial shoots persist for only one season, is rare among the Dicotyledones, less so among the Monocotyledones: *Dioscorea, Polygonatum, Smilacina, Streptopus, Medeola, Oakesia,* and others. In *Dioscorea, Polygonatum* and *Smilacina* the internodes of the rhizome are very short, and the roots relatively thin. In *Oakesia sessilifolia*, on the other hand, the rhizome is more slender, and with the internodes very long; moreover the roots are relatively thick, containing large deposits of starch in the cortex. A very singular structure is exhibited by *Medeola Virginiana* L. The horizontal rhizome consists of an oblong tuber with three to four internodes with small scale-leaves, and with several slender roots proceeding from near the leaves. A large bud appears close to the apex of the tuber at the stage of hibernation, which in the succeeding spring develops into a tall flower-bearing stem with several whorls of leaves (four to five in each whorl), and with the umbellate inflorescence at the apex. A long, slender internode, terminated by a small tuber, becomes developed in the course of the summer from the apex of the old tuber, and judging from the position of the scale-leaves, which surround the base of the floral shoot, it appears as if the rhizome represents a monopodium, thus agreeing with *Paris* according to Alexander Braun and Irmisch.

While a typical, horizontally creeping rhizome with the internodes more or less stretched is represented by *Commelina hirtella* Vahl, we observe a very different structure in *C. Virginica* L., and *C. erecta* L. In these species the rhizome is very condensed, since no horizontal internodes are developed. The bud at the apex of the rhizome develops at once an erect shoot. In *Tradescantia rosea* Vent. the rhizome is horizontally creeping, the internodes stretched, and the roots, frequently two at each node, are relatively thick. The rhizome branches freely, and several branches may develop into floral shoots in the same year. The ramification

is monopodial until the first flowering, and the basal internode of each lateral branch partly fuses together with the main axis.

Croomia pauciflora Torr. has also a creeping rhizome with the internodes stretched, and with the long, somewhat fleshy roots developed from the nodes, thus resembling Oakesia. At the stage of rejuvenation the large, terminal bud, covered by only two membranaceous, scale-leaves, develops into a flowering stem, while a bud in the axil of the outermost scale-leaf grows out, and continues the rhizome, which thus represents a sympodium. This type of rejuvenation with only a single leaf (the younger stages) or a single floral stem is very frequent in plants with creeping rhizomes, but occurs, also, in connection with a vertical rhizome as in *Trillium*, for instance. In some of the *Orchidaceae, Orchis spectabilis* L., several species of *Platanthera* e. g. *P. clavellata* Michx., *P. obtusata* Pursh, *P. dilatata* Pursh, etc., the rejuvenation depends also upon the development of a single floral shoot, or a single leaf at the youngest stage. Only one large storage-root is in these developed beneath the shoot, beside one pair of slender, much longer nutritive roots. The stage of hibernation (fig. 45) shows the bud for the next year fully equipped with the same type of root-system as the floral shoot; between the floral shoot and the hibernating bud is a long, descending internode (S).

Much more frequent, however, is the type of rejuvenation, where each shoot persists for more than one year, and where several green leaves form a more or less distinct rosette around the base of the flower-bearing stem. In *Cimicifuga racemosa* for instance, the stout, horizontal rhizome consists of relatively short internodes, covered by large, membranaceous, scale-leaves; the secondary roots are strong, of quite a considerable length, and contain starch. A large bud terminates the rhizome, and at the stage of rejuvenation it develops into a tall, flower-bearing stem with mostly two or three large, green leaves at the base. Characteristic of *Cimicifuga* is the appearance of a small bud in the axil of the innermost green leaf, and this bud, although remaining dormant for several years, continues to develop very short internodes with scale-leaves in the manner of a dwarf-shoot.

In *Heuchera Americana* L. the creeping rhizome bears several thick roots of the storage-type, and they are amply ramified. A flower-bearing scape and several green leaves develop from the terminal bud, and several of the leaves persist throughout the winter. This type of hibernation and rejuvenation is frequent among the Dicotyledones with horizontal rhizomes. In *Hepatica triloba* Chaix var. *Americana* DC. the rhizome is vertical, and seldom branching; the terminal hibernating bud is always situated close to the surface of the soil, and is surrounded by several membranaceous, scale-leaves, besides that the green leaves from the preceding year's growth form a rosette around the bud. The stage of rejuvenation is marked by the development of several solitary flowers borne on slender scapes, while the foliage appears a little later. Regarding the seedling Hildebrand has described this, and it is interesting to notice that the plumule develops several scale-leaves before the green, three-lobed appears; in *Anemone nemorosa, A. blanda, A. narcissiflora,* etc., the plumule is kept beneath the surface of the soil, and the first leaf is aerial and shows already the final leaf-structure.

Horizontal rhizomes are also very common in the *Gramineae, Cyperaceae* and *Juncaceae,* besides several *Iridaceae,* etc. Most frequently the shoot is terminated by the inflorescence; but in the genus Carex the ramification is sometimes monopodial, so that each shoot represents an apical tuft of leaves with the flower-bearing stems proceeding from the axils of the leaves of the previous year. In *Tripsacum dactyloides* L. the very stout rhizome is almost above ground; in *Iris verna* L. and *I. cristata* Ait., the structure of the rhizome resembles that of *Podophyllum,* consisting of tuberous-thickened internodes alternating with slender ones. The stout vertical rhizome of *Symplocarpus foetidus* (L.) Nutt. represents a monopodium; in the very early spring one to several, almost sessile inflorescences, partly surrounded by membranaceous, scale-leaves, appear close to the apex of the rhizome. The apex itself, however, is purely vegetative and develops into a large rosette of green leaves, persisting until the fall. The stage of hibernation shows the rhizome with

remnants of the withered leaves, some of which subtend buds, containing the flowers for the next spring.

While thus the rhizomes themselves exhibit very distinct, external structures, the hibernating buds may also develop in a very different manner: as a lateral, purely floral and a terminal, purely vegetative shoot, when the ramification is monopodial, or into a combination of both, when sympodial. The stage of rejuvenation frequently appears as a repetition of the growth, which we have observed at the younger stages of the plants, sometimes even including the seedlings. The very earliest development of the rhizome may be looked for during the first or second year of the seedlings; in no other way can we feel assured that the subterranean stem, we have before us, is a primary structure, a true rhizome, instead of some lateral shoot, a stolon for instance. In rhizomes, which ramify, the branches always show the same structure as the main axis, the same type of internodes, slender or thick, short or stretched, and furthermore the same kind of leaves, membranaceous, sheathing or scale-like, etc., while in stolons the structure differs considerably from that of the main stem.

While the rhizomes s. s. are mostly developed by the plumule, the pseudo-rhizomes represent a combination of the hypocotyl, the persisting bases of the aerial shoots with their buds, and sometimes the primary root. Hj. Nilsson, who proposed this term, has given an enumeration of dicotyledonous plants, exhibiting this structure, among which are several species of *Paeonia, Orobus, Sedum, Agrimonia, Viola* (caulescent), *Campanula,* etc. Many of the North American herbs possess this type of rhizome, and it is especially frequent in the *Papilionaceae, Compositae,* etc. We have seen, how such rhizome may begin already during the first rejuvenation in *Baptisia tinctoria* (Fig. 32), where the primary root persists, where the contractile hypocotyl draws the cotyledonary buds down into the ground, and where these develop into aerial shoots with only the basal internodes persisting. These stem-bases in connection with the hypocotyl thus represent a pseudo-rhizome and the stage of rejuvenation thus depends upon the development of a number of axillary shoots. In *Cunila* (Fig. 29) the shoots are al-

ready to be observed during the fall as small fleshy branches with scale-leaves.

A somewhat complicated structure is exemplified by *Ludvigia alternifolia* L., and the habit of this plant is remarkably well illustrated by the seedling in the course of the first summer. The cotyledons are epigeic, and subtend no buds; the hypocotyl is long, erect, and the shoot is purely vegetative; the primary root is long, and becomes distinctly swollen at the base, forming a fusiform tuber during the first summer; secondary roots, about six in two rows proceed from the lower part of the hypocotyl, at a short distance from the tuber. The first stage of hibernation shows us only the base of the hypocotyl with the slender secondary roots and the tuberous part of the primary besides a small, scaly bud situated between the secondary roots. This bud is adventitious, and develops into an aerial shoot during the first rejuvenation. A little later on the root-system becomes changed, since the primary root-tuber dries up, becoming substituted by two or three lateral ones of the same structure, originating from some of the secondary roots of the hypocotyl. The future stages of hibernation and rejuvenation show a steady increase in the number of the slender, secondary roots, and consequently also of the tuberous, besides of the hibernating buds; the individual may live for about five or six years, becoming fertile already in the second year. Large specimens may show as many as fifteen fusiform roots, all occupying a horizontal position, and being of a different age, one or two years. The number of hibernating buds may aggregate about eight in such large specimens, but, as a rule, only one or two floral shoots are developed. The subterranean axis thus consists of the persistent part of the hypocotyl, bearing the roots and the buds, in other words a typical pseudo-rhizome. It seems strange that the tuberous roots, which last only from the latter part of the summer until the next spring, are covered by many layers of cork, and contain so much thick-walled hadrome; otherwise the structure is that of a storage-root, the secondary cortex and the parenchymatic rays in the stele being filled with starch. The root-structure is thus very different from that of the large storage-roots of *Cicuta* and *Archemora*, although these

plants grow associated with *Ludvigia*. Regarding the hibernating buds in *Ludvigia* these represent shoots rather than buds; the axis is relatively thick, but the leaves, apparently opposite, are membranaceous and scale-like.

In the perennial *Oenothera linearis* Michx. the stage of hibernation is very different from that of *Ludvigia*, described above. In this species of *Oenothera* the pseudo-rhizome is also very short, and bears several tuberous roots from one to about five, of a globular shape, and of a dark-brown color. But the hibernating shoots represent relatively large rosettes of green leaves, and numerous long, white, secondary roots proceed from the base of these rosettes. In large specimens with remnants of five floral shoots as many as ten to fifteen rosettes may be observed during the winter.

According to Nilsson storage-roots occur in several plants with pseudo-rhizome e. g. various species of *Paeonia*, *Dahlia*, *Sedum*, *Asclepias*, and *Salvia patens* Benth. Stolons s. s. on the other hand, are absent. Likewise the true rhizomes the pseudo-rhizomes may persist and remain active for many years.

As a primary structure tubers and bulbs are exceedingly well represented in the Monocotyledones, but rare in the Dicotyledones. We have seen the tuber becoming developed already at the seedling-stage in *Arisaema*, and the growth continues in the same manner until the tuber becomes terminated by the inflorescence; from that time the growth of the tuber becomes continued by a bud, developed in the axil of the first green leaf, thus the original monopodium becomes changed to a sympodium, exactly as in most of the monocotyledonous rhizomes (*Iris*, *Uvularia* etc.) Very characteristic structures are exhibited by the tubers in the *Orchidaceae;* they may represent separate shoots (*Aplectrum*, *Tipularia*, *Calypso*, *Calopogon*), or simply the swollen base of the flowering stem (*Liparis*, *Microstylis*), or finally as in *Arethusa* the swollen base of the flowering stem and a tuberous internode, belonging to the subterranean axis. In *Aplectrum* and *Calypso* the tubers are sometimes connected with branched rhizomes of exactly the same structure as we know from *Corallorrhiza*, and it is interesting to notice that in *C. odontorhiza* Nutt. the basal internode of the flower-

bearing stem forms a roundish tuber, borne upon the apex of one of the coral-like shoots. In *Aplectrum hyemale* (Muehl.) Torr. the subterranean stem is horizontal, partly slender, and partly tuberous i. e. the growth of each year results in the development of a slender, horizontal stem of mostly four internodes, and an ascending tuber of c. six internodes. The root-system is of long, slender roots proceeding from the basal internode of the tuber. All the leaves of the slender and tuberous part are membranaceous, scale-like or sheathing, with the only exception of a large, green leaf appearing close to the apex of the tuber, and this leaf hibernates. In the course of the following spring the inflorescence appears, developed from the axil of the membranaceous leaf beneath the green one. A very small dormant bud may be observed at the apex of the tuber, and being purely vegetative the complete axis of slender and tuberous internodes thus represents a monopodium. The hibernating stage shows the large, green leaf and several membranaceous leaves at the swollen base, the roots, and the horizontal, slender stem passing into a tuber from the preceding year. The rejuvenation depends upon the appearance of the inflorescence during the spring, and the development of a large bud in the axil of the second membranaceous leaf (counted from below) of the tuber. which grows out as a slender, horizontal shoot continuing the growth and direction of the entire subterranean axis.

In *Tipularia discolor* (Pursh) Nutt. the tubers show exactly the same structure as those of *Aplectrum*, but the slender internodes between the tubers are hardly to be seen, since they are so exceedingly short, and only three are developed. Hibernation and rejuvenation are marked by the same structures as in *Aplectrum*, and the single leaf persists through the winter. *Calypso borealis* Salisb., shows the same growth as *Aplectrum* and *Tipularia*, and likewise the latter the slender internodes, one or two, are very short. The tuber consists only of two distinct internodes, with the single flower developing from the axil of the second membranaceous leaf (counted from below), and with the green leaf beneath the minute apical, vegetative bud; a large bud situated in the axil of the lowermost membranaceous leaf of

the tuber will continue the growth of the subterranean axis. Characteristic of *Aplectrum*, *Calypso* and *Tipularia* is thus: the single, green leaf persisting through the winter; the apex of the tuber being a dormant, vegetative bud, and the inflorescence consequently lateral; the coral-like rhizome occurring beneath the tuber in *Calypso* and *Aplectrum*, but absent from *Tipularia;* the last genus shows, on the other hand, the remarkable root-structure with a velamen distinctly developed, although the plant is terrestrial. A very different structure is represented by *Calopogon pulchellus* R. Br., although the tuber and the few, very short, slender internodes between resemble those of *Tipularia*. But in *Calopogon* the tuber consists only of two internodes, the apical tapering into a very small shoot with one membranaceous and one green leaf, surrounding the base of the terminal inflorescence. The bud to continue the growth of the subterranean axis is situated in the axil of the second scale-leaf of the tuber (counted from below). The roots are confined to the slender internodes. Branched tubers may occur, and the lateral tuber has then been developed from a bud in the axil of the first leaf of the tuber, which otherwise stays dormant. With the exception of the coaetaneous appearance of the inflorescence and the green leaf the rejuvenation exemplified by the tuber resembles that of the genera described above, *Aplectrum*, etc.

In *Arethusa bulbosa* L., as mentioned above, the tuber consists of two internodes, of which the apical represents the base of the floral scape. At the stage of rejuvenation the old tuber is borne upon a long, slender, vertical internode, and the floral shoot arises from a cavity on the frontal part of the apical internode. This cavity is already at the time of flowering visible at the base of the floral scape, and it surrounds a bud, which is actually situated in the axil of the single green leaf. This bud is the one that will continue the growth of the axis, and its lateral position is also indicated by its first leaf being an adorsed prophyllon. From the external appearance of the floral shoot of *Arethusa* at the time of flowering we should not expect such rather complicated structure to be hidden within the long, tubular leaves. Nevertheless above the prophyllon and the succeed-

ing membranaceous leaf a long slender internode is developed, passing into a tuberous internode with a green leaf subtending a bud, and terminated by the flowering scape, with the basal distinctly swollen. With regard to the root-system there are generally six long, slender roots developed from the base of the floral shoot i. e. from the base of the long internode above the prophyllon.

Liparis liliifolia Richard shows a more simple structure of the vegetative organs. At the time of rejuvenation the floral shoot appears close to the base of an old tuber, globose and with no remnants or scars from leaves. The floral shoot begins with an adorsed prophyllon, followed by a few, mostly two, membranaceous leaves preceding the two large green ones, which surround the terminal, floral stem. By removing the leaves we notice the swollen base of the floral stem, and a bud belonging to the axil of the innermost green leaf, but partly enclosed within a cavity at the base of the swollen stem. The roots, mostly six, are slender, and proceed from the base of the tuber. Characteristic of *Arethusa* and *Liparis* is thus the participation of the floral stem in forming the tuber; in *Liparis*, as a matter of fact, the entire tuber represents the basal portion of this stem; furthermore the cavity at the swollen stem-base partly enclosing the hibernating bud is also peculiar to these two genera. While tubers are well represented in this family (*Orchidaceae*), not a single genus has been observed, so far, to develop bulbs.

Tubers of the first order, developed from the plumule itself are very rare among the Dicotyledones, but we observed such in *Dentaria laciniata* (Fig. 33) as described above. Formed by the hypocotyl, on the other hand, primary tubers are known from *Collinsonia*, *Scrophularia nodosa* (including the epicotyl), *Cyclamen*, *Umbilious*, *Eranthis*, several species of *Corydalis* etc. In *Dentaria laciniata* the rhizome of the mature plant consists of a horizontal chain of oblong tubers, each representing the growth of one year. In the other genera, mentioned above, the primary tuber persists as a single more or less irregularly tuberous body so long as the plant lives.

Tubers of secondary order, developed at the apex of stolons are infrequent among the Monocotyledones, some few

Cyperaceae: *Scirpus maritimus* L. *Cyperus rotundus* L., and *C. phymatodes* Muehl.; *Haemadoraceae*: *Lachnanthes tinctoria* (Walt.) Ell.; *Alismaceae*: *Sagittaria; Marantaceae*: *Maranta arundinacea* (L.) In *Fuirena squarrosa* Michx. the rhizome produces dimorphous shoots: flower-bearing stems with stretched internodes, and, alternating with these, tubers, consisting of only one internode, and with the apical bud remaining dormant; large deposits of starch were found in these tubers. The plant is perennial, but it is not seldom to find small specimens developed in the autumn, which lack these tubers, and which do not persist through the winter. In certain *Gramineae* the subterranean internodes of the culms become tuberous, for instance, in *Melica, Panicum, Ehrharta,* and Hackel considered these tubers to represent water-reservoirs. In *Avena bulbosa* Willd., on the other hand, Seignette found a large quantity of starch in its tubers.

Among the *Dicotyledones* tuberiferous stolons are not infrequent, in the *Labiatae,* but otherwise they are mostly known from small genera; *Hydrocotyle* (*H. Americana* L.), *Circaea, Trientalis, Cynthia,* or from a few species of the larger: *Oxalis, Solanum, Helianthus, Senecio* etc. Stolons of this type appear frequently at the seedling-stage, from the axils of the cotyledons, and as stated above, they may represent the only part left of the mother-plant at the close of the first season. While the slender internodes gradually wither during the winter, the tuber persists, develops roots in the early spring and produces a new individual. It is very frequent, that the seedling itself does not attain the stage of flowering, while the tuber may grow out as a flowering shoot already in the first year after hibernation. The tubers do not, as a rule, persist for more than one season, but they give rise to axillary stolons, becoming terminated by tubers, and repeating the growth in the next season. Moreover the new individual generally shows the habit of the seedling to produce stolons, thus the distribution of the plant over a large area, and, at the same time, the abundance of individuals becomes effected by means of tuberiferous stolons. A unique type of stolons is represented by *Apios tuberosa* Moench. which we have described in this

journal (May 1924). The long, horizontally creeping stolons consist of many internodes, several of which increase in thickness so as to form tubers, arranged at intervals like beads. These tuberous stolons persist in an active condition for several years, giving rise to terminal, aerial shoots "vines," or to lateral, becoming stolons. The roots are always confined to the tuberous portion of the stolons; they are sparingly branched, and bear bacterial tubercles.

Tubers of second order thus represent some very distinct structures: the basal, cauline of the *Gramineae*, the sessile of *Fuirena*, the bead-like in Apios, and the typical tubers terminating the stolons in the *Labiatae*, etc. Those of the *Gramineae* and *Fuirena* take no direct part in the vegetative reproduction; they are simply storage-organs. In the others they are not only storage-organs, but they perform also the function of contributing to the distribution of the plant.

The typical bulb represented by the *Liliaceae* (*Allium, Lilium, Erythronium, Ornithogalum,* and *Amaryllidaceae Hymenocallis, Narcissus, Zephyranthes*) is very seldom to be found in the Dicotyledones. As described by Irmisch the structure of bulbs shows several modifications with regard to the position of the floral scape being terminal or lateral; the number of the nutritive leaves, varying from one to many, and their shape, the base being very narrow, or broad, enclosing the axis more or less completely.

The bulb is most frequently, if not always, a primary structure, and in several genera it may be traced already from the seedling-stage, before the first hibernation. But for several years the rejuvenation depends only upon the development of a single, green leaf, and a bud. The root-system is very uniform, the long, slender, unbranched roots being of the nutritive type. In *Erythronium Americanum* Ker. the stage of flowering is preceded by a purely vegetative growth for several years, where the young bulb produces several lateral stolons beside a green leaf. These stolons are developed in the early spring; they consist of a single, but long internode, of which the apex becomes a bulb in the course of the summer. The internode of the stolon dies off very soon, and the secondary bulb thus becomes separated from the mother-plant, giving rise to a new indi-

vidual in the succeeding spring. When the plant has attained the flowering stage, no stolons become developed, the shoot dying off completely. We have, thus, in *Erythronium Americanum* the rare occurrence of a bulb producing bulbiferous stolons.

Among the Dicotyledones true bulbs are known from a very few plants, and *Oxalis* is the only genus, so far as we know, where they occur. In *Oxalis violacea* L. the bulb-structure appears already at the seedling-stage, and in mature specimens the bulb itself differs in no respect from the typical one of the Monocotyledones. But in this species of *Oxalis* bulbiferous stolons become developed from the bulb, following the same course of hibernation and rejuvenation as we have seen in *Erythronium*. Moreover a large storage-root may become developed beneath the bulb (Fig. 36), but this is no constant character. We have observed such water-storage-roots in mature as well as in younger specimens, and they are only to be found in the spring. Arechavaleta, Chauvel, and Hildebrand have described the occurrence of such bulbs in various species of *Oxalis*: *O. Macachin* Arech., *O. Bowiei* Lindl., *O. cernua* Thunbg., *O. Coppoleri* Tod., and *O. rubella* Jacq.

Bulb-like structures, on the other hand, are exemplified by several Dicotyledones. We have mentioned *Viola papilionacea, Dentaria diphylla, D. bulbifera, Dicentra Cucullaria,* and *Hydrophyllum Canadense,* where such structure occurs in the rhizome of the mature plant, and sometimes even to be traced from the seedling-stage. As secondary structures they have been observed in *Lithophragma tenella* Nutt. (figs. 43-44), upon the subterranean stem-portion, but the bulb-scales are borne upon a distinct, elongated axis. In *Claytonia Chamissonis* Esch. similar bulbs are developed at the apex of long stolons, already at the seedling-stage, from the axils of the cotyledons, and a corresponding structure recurs in *Epilobium palustre* L. In the genus *Saxifraga* sessile bulblets occur at the base of the aerial shoot and in the axils of the inflorescence of *S. cernua* L., *S. bulbifera* L. and *S. granulata* L. Similar aerial bulblets are known also from *Claytonia parvifolia* Moc., and from *Dentaria bulbifera* L. But whether subterranean or aerial these bulb-like shoots or

buds are of great importance to the distribution of the plants, even if the aerial are, sometimes, replacing the flowers as in the arctic-alpine *Saxifraga cernua,* and in the far southern alpine *S. bulbifera.*

We have seen from the preceding pages that stolons may be terminated by tubers or bulbs, but the most frequent structure is, that all the internodes are slender, thus the apical as well as the lateral buds develop into aerial shoots without any previous formation of tubers or bulbs. In *Uvularia perfoliata* the rhizome of the mature plant is vertical, very short, and entirely concealed by the scale-leaves; the roots are relatively thick, very long, and sparingly branched. The stage of hibernation is merely represented by the rhizome with some buds and the root-system. At the time of rejuvenation the large, apical bud of the rhizome grows out as an erect, flowering stem, while some buds, generally two, situated in the axils of the scale-leaves develop into very long, slender, rootless stolons with stretched internodes and with long, tubular, membranaceous leaves; the first leaf of the stolon is an adorsed prophyllon, thus indicating the lateral position of the stolon. In the course of the summer the stolons cease to grow and roots begin to develop at the apex, and attain a considerable length during the fall; at that time the stolons, with exception of the apical bud, have withered, and the apex with the roots are then in the position to hibernate. With regard to the flowering stem, this dies down to the ground, when the fruits have matured, but the rhizome itself may persist for a year longer, since there is generally a large bud visible at the base of the flowering stem, and a new system of roots becomes developed before the winter sets in. *Uvularia perfoliata* thus represents a plant with typical stolons, and with an exceedingly short, vertical rhizome. A similar structure recurs in *Maianthemum Canadense* Desf., but the stolons of this plant persist for several years, and remain in connection with the mother-shoot. While thus the stolons may be readily distinguished from the shoot, that bears them, in *Uvularia* and *Maianthemum,* it is rather a difficult matter to decide, whether we have a rhizome or a stolon before us, when we consider the subterranean stems of several *Gramineae, Cyperaceae* and

Juncaceae. In some of these the subterranean stems resemble stolons throughout, while in some others they look more like rhizomes. We have spoken of a rhizome in *Tripsacum*, because the stout, horizontally creeping stem resembles the typical rhizome of *Acorus*, all the leaves being aerial, green. One might, on the other hand, feel tempted to define the scaly, subterranean shoots of *Leersia Virginica* Willd., several species of *Muehlenbergia*, *Uniola latifolia* Michx. and some others, as stolons rather than rhizomes, although their actual position is identical with that of other creeping shoots in the *Gramineae*. According to Warming (1923) rhizomes do not seem to occur in the *Gramineae*, but in the *Cyperaceae* and *Juncaceae;* stolons are according to this author very frequent in the *Gramineae*, besides in the two other families. How to draw the distinction is another question. Warming himself (l. c. p. 165) held the opinion, that no absolute distinction could be drawn between stolons and rhizomes.

But we have seen in *Uvularia* and *Oakesia* how the stolons originate in the former: from the axils of the scale-leaves, and the rhizome in the latter: from the plumule itself. Moreover the stolons in *Uvularia* deviate in structure considerably from the short rhizome, that bears them, while the branches of the creeping rhizome of *Oakesia* differ in no respect from the main rhizome. Such comparison may be applicable also to the *Gramineae*, *Cyperaceae* and *Juncaceae*. In *Tripsacum*, for instance, we find a typical rhizome, creeping, extensively branched, and destitute of stolons. A similar structure recurs in *Panicum virgatum* L. In *Leersia*, *Muehlenbergia* and *Uniola*, mentioned above, horizontal shoots develop from the axils of leaves belonging to a floral or vegetative shoot, of which the subterranean stem is exceedingly short, but amply provided with roots. These lateral shoots bear only scale-leaves, and they remain rootless until the succeeding spring. The young stages of many *Gramineae*, examined so far, show a corresponding structure with one or several lateral, creeping shoots becoming developed from the basal leaves of the primary. There is no indication of any horizontal rhizome, and the lateral shoots unquestionably represent stolons, to the same extent as those described

in *Uvularia*. The very long horizontally creeping shoots of *Spartina, Distichlis, Agrostis* and many other grasses are also stolons, according to our opinion. Moreover, we have in some genera: *Agrostis, Glyceria, Stenotaphrum,* etc., species of which corresponding, lateral shoots, but aerial and with green leaves, represent typical runners.

This type of stolons with the apex slender is frequent in the dicotyledons, and may be developed from the axils of the cotyledons, or from the basal leaves of the mature plant. Likewise the tuberiferous type these stolons may not persist for more than one season, leaving the apical bud to hibernate and produce a new individual during the next spring. Or they remain in connection with the mother plant for several years, branching freely, but retaining the structure of stolons until the apex develops into an aerial shoot. The aerial shoots may live for only one season, or, as for instance in some of the *Compositae,* the basal internodes may persist for several years. Stolons of this type may occur in genera, of which other species have tuberiferous stolons as for instance in the *Labiatae,* as mentioned above (*Lycopus, Scutellaria*); most frequently, however, they represent the only type characteristic of the genus: *Berula angustifolia* Mertens et Koch, (Warming 1876-1877), *Gratiola viscosa* Schwein., *G. aurea* Muehl. *Chelone glabra* L., *Lysimachia quadrifolia* L. etc. In some of the *Compositae* the stolons persist for several years, and develop into a rosette of leaves preceding the floral stem, which generally appears in the following season as in *Achillea millefolium* L. In *Coreopsis verticillata* L., on the other hand, the long stolons, rootless during the winter, hibernate in connection with the mother-plant, and develop immediately into a floral shoot without forming a rosette of leaves. *Aster divaricatus* L. has stolons of considerable length, but these are amply provided with roots, proceeding from the nodes. Many of the scale-leaves subtend buds, which grow out as stolons. The aerial shoot begins with some few, four or five, short internodes and small scale-leaves preceding the green ones, which are alternate, and not forming any basal rosette. There is generally a large bud visible in the axil of one of the scale-leaves, which grows out as a floral shoot during the next

year. Purely vegetative shoots are also devoloped from stolons, but they die down to the ground during the first season, apparently leaving no buds to hibernate. It is thus characteristic of *Aster divaricatus*, when compared with most of the other species of the genus, that stolons are so well represented, and that the flower-bearing stem is not preceded by any rosette of leaves, while purely vegetative shoots are developed from separate stolons.

It is interesting to notice that stolons are also represented by arctic and alpine plants, for instance in *Oxyria digyna* (L.) Hill (arctic and alpine), *Halianthus peploides* (L.) Fr. (arctic), *Stellaria umbellata* Turcz. (alpine), *Epilobium Hornemannii* Reich. (alpine), *Polemonium caeruleum* L. var. *villosum* (Rud.) Brand (arctic). *Pedicularis lapponica* L. and *P. capitata Adams* (arctic), and numerous *Gramineae* and *Cyperaceae* in both regions.

The runners are aerial, plagiotropous branches, developed from the axils of the leaves of an orthotropous, aerial shoot; they may consist of a single or many internodes; they may be terminated by a rosette of leaves, and subsequently by a flowering stem, or they may remain as purely vegetative shoots, monopodia. As compared with the stolons the runners represent a larger number of types, but they very seldom bear tubers or bulbs. *Antennaria neglecta* Greene may be mentioned as an example of the simplest type. In mature plants the stage of rejuvenation shows a rosette of spatulate leaves and a central flower-bearing stem; long, horizontally spreading runners become developed from the axils of the leaves of the rosette; they consist of several internodes, and the leaves are shorter and much narrower than those of the rosette; furthermore they are completely rootless. During the early part of the summer the rosette and flowerbearing stem die down to the ground, while the runners begin to form terminal rosettes, from which roots become developed; finally the other parts of the runners wither and the new rosettes with their roots and a central bud are left to hibernate. This type of runners is characteristic of the genus, and especially well represented by *A. Parlinii* Fernald, *A. plantaginifolia* (L.) Richards, *A. fallax* Greene etc. In *Erigeron bellidifolius* Muehl. the runners root freely

at the nodes before the new rosettes are developed, but otherwise the structure agrees with that of *Antennaria*. A very different type is, however, exhibited by *Erigeron flagellaris* Gray. The primary root and the leafy rosette persist for several years, producing long, slender runners with many small leaves subtending flower-bearing stems, and rooting at the apex, where new rosettes become developed; the runners branch freely thus many new individuals become developed from each plant. The arctic-alpine *Saxifraga flagellaris* Willd. has runners consisting of a single, relatively long internode terminated by a rosette; while the mother-plant dies after the first flowering, the new rosettes become provided with roots and winter over, but remain vegetative for a few years until the terminal, floral shoot appears. The development of runners does not begin until the plant has attained the flowering stage. In *Claytonia sarmentosa* C. A. Mey. the aerial shoot represents a monopodium; it consists of a rosette of leaves, which winters over, and from the axils of which flowering stems are produced in the succeeding spring. Runners of one or several internodes become developed from the axils of the leaves from the previous year, and form new rosettes. Secondary roots develop from the internodes of the runners. An interesting structure is shown by *Stellaria pubera* Michx.; while the plant is still blooming, a few erect purely vegetative shoots begin to develop, of which the leaves are always larger than those of the floral shoots. While the floral shoots die almost to the ground as soon as the fruits have matured, the vegetative shoots do not only remain active, but they continue their growth until late in the fall. At the close of the season these shoots have become closely appressed to the ground like runners, and winter over. At the stage of rejuvenation a number of flowering stems develop from the nodes of these runners, and the internodes gradually withering, a series of independent individuals is produced, repeating the structure of the mother-plant with floral and vegetative branches. Sometimes a few-flowered inflorescence may appear at the apex of the large, vegetative shoots, and although these flowers become developed much later than the others (those of the normal, floral shoots), they are nevertheless, perfect, and

sometimes even larger than the earlier ones. Furthermore the lowermost internodes of the floral shoots persist with some buds, and continue to grow in the manner of a pseudo-rhizome, thus *Stellaria pubera* is one of the few plants in which a pseudo-rhizome as well as runners are represented. A corresponding method of vegetative reproduction is to be observed in *Phlox divaricata* L. with the only exception that the runners persist for several years, continuing their growth and developing axillary shoots without becoming separated from the mother-plant.

It is characteristic of this type of runners that their foliage differs from that of the flowering stem by being generally smaller and narrow, except *Stellaria pubera*, where the leaves are much larger. Another type is represented by *Potentilla Canadensis* L., and several other species of the genus. The seedling of *Potentilla Canadensis* has hypogeic cotyledons, and the plumule develops at once into a runner-like shoot with the internodes stretched. In the mature plant the leaves form a rosette, from the axils of which long procumbent runners become developed. They consist of several long internodes, and there is a typical green leaf, two bracts, and a flower at each node; the flower is terminal, representing the apex of the long internode, while the runner becomes continued by another long internode developed from the axil of one of the bracts. The structure is as follows: The apex of the runner bears two small, rudimentary leaves with the stipules distinct, but the blade minute, bract-like; of these leaves the lower one subtends a short, erect, vegetative branch with only one large, typical leaf, while the upper one subtends a long shoot, the continuation of the runner; as stated above, the flower is terminal. The runners thus show a series of small, root-less shoots separated from each other by long internodes. In the course of the summer most of the shoots wither, while the long internodes remain active until the fall. At that time one of the apical shoots has begun to develop roots, and we notice that the small vegetative branch has not only increased in thickness, but has also begun to develop leaves. In other words a new individual is about to be formed, and during the winter this little plant is represented by a small tuber, bearing a rosette

of four to five typical leaves, and provided with several long, amply ramified roots; the long internodes of the runner have withered completely. The shoot of the mother-plant hibernates also as a rosette of green leaves devloped from the apex of the tuberous rhizome, thus representing a monopodium.

In *Ranunculus Cymbalaria* Pursh long runners are also developed from the rosette of the mother-plant. But these runners are monopodia, and numerous small rosettes of leaves are developed at the very distant nodes, rooting freely and developing several flowers. At the close of the first season the long internodes wither, and each rosette becomes an independent individual, which hibernates.

The genus *Hydrocotyle* incl. sectio *Centella* is an interesting genus from this particular point of view: hibernation and rejuvenation. It represents three types: one with tuberiferous stolons besides slender runners, another with rosette-bearing runners, and finally a third type, a creeping herb with the axis representing a monopodium, the inflorescences being axillary. Of these types *Hydrocotyle Asiatica* L. shows exactly the same habit as *Ranunculus Cymbalaria*. The runners are monopodia, and the secondary shoots consist of rosettes of leaves with axillary inflorescences, and root freely. The seedling has epigeic cotyledons, and a distinct hypocotyl; the slender primary root is not persistent, and becomes replaced by secondary roots proceeding from beneath the cotyledons; the first leaf of the plumule shows the shape typical of the species, oblong-reniform, repand-toothed. We have mentioned the tuberiferous stolons of *Hydrocotyle Americana*, but this species develops also long, creeping runners from the axils of the leaves of the upper part of the main stem. The foliage of the runners shows the same shape as those of the stem, but the petioles are much shorter. Although these runners bear several roots beneath the leaves, they hardly persist through the winter, inasmuch as we have never found any plants developed from hibernated runners, while the tubers produce new individuals in abundance. This species of *Hydrocotyle* has no rosette of leaves; the very slender stem is profusely branched, the branches thus representing runners above ground,

and subterranean, tuberiferous stolons. It is the only member of the family exhibiting this type of habit. So far as concerns the structure of the runners *Hydrocotyle Americana* forms a transition to another group of plants, where the runners do begin as axillary, cotyledonary shoots, and later on as lateral branches in the mature plant, but showing exactly the same structure as to length of internodes and shape of leaves as the main stem. This type of runners is exhibited by *Glechoma hederacea* L. according to Irmisch. All the shoots are aerial, and the leaves persists through the winter. At the time of flowering the shoots become somewhat erect, but when the fruits have matured, the axis becomes extended beyond the inflorescence, and grows out in a horizontal direction, representing a long, rooting runner. In other words the inflorescence in *Glechoma* is not terminal as in most of the other *Labiatae*, and the main axis as well as the lateral shoots develop as runners, profusely branched.

Among the Monocotyledones runners are poorly represented, and it is only in the *Gramineae* that these shoots are sufficiently distinct from the others, so as to be defined as runners; they occur in *Agrostis alba* L. var. *stolonifera*, *Glyceria maritima* Huds., *G. angustata* R. Br., *Festuca rubra* L. etc. The long creeping shoots of *Juncus repens* Michx. and *J. subtilis* Mey., may also be considered as runners..

Typical runners are thus mostly connected with rosettes of leaves as we have seen in *Antennaria*, *Erigeron*, *Saxifraga*, *Claytonia*, *Potentilla*, *Ranunculus*, and *Hydrocotyle* sectio *Centella*. Less characteristic are those of *Stellaria*, *Phlox* and *Glechoma*. *Glechoma* actually forms a transition to the group of plants, which is generally called "creeping herbs," which have no runners, but of which the branches are creeping, and all bearing the same type of leaf, as is characteristic of the species. This type of plants is represented by a number of Dicotyledones, of very different families, and mostly of some few species of large genera. But considered from the view-point: hibernation and rejuvenation, the creeping herbs do not show much of interest. The simplest type is represented by *Hydrocotyle umbellata* L., *H. verticillata* Thunbg., and *H. ranunculoides* L. f. where

the stems are monopodia, rooting at the nodes, and with one leaf and one axillary inflorescence at each node. In *Dichondra repens* Forst. the single, axillary flowers appear near the apex of the shoots; *Lippia nodiflora* Michx. and *L. lanceolata* Michx. have opposite leaves, and one axillary inflorescence at each node; in the terrestrial form of *Ludvigia palustris* (L.) the stems are creeping, the leaves opposite with axillary flowers. In *Lysimachia nummularia* L. the primary shoot grows out as a long monopodium with the opposite leaves persisting through the winter. The lateral shoots are either axillary flowers or vegetative branches of the same structure as the primary. *Coccocypselum repens* Sw. shows the same habit. The seedling has epigeic cotyledons, a short hypocotyl, but the primary root withers early, becoming replaced by several secondary roots, the first one proceeding from beneath the cotyledons, between these. The long epicotyl is ascending, and for a few months the shoot is erect. The mature plant, however, is creeping, the primary axis remaining as a long monopodium as in *Lysimachia;* the inflorescences are borne upon short, lateral branches; secondary roots become developed from the internodes of the branches, and new individuals become produced, when the posterior part of the mother-shoot gradually dies off. *Evolvulus nummularius* L. grows in the same manner, closely appressed to the ground, and the single flowers appear near the apex of the lateral branches; strong secondary roots are developed from the nodes, but only one at each node. Several species of *Veronica* belong to this type, and the stems show the same monopodial structure as described above. Finally the genus *Asarum* shows quite an interesting structure, and very distinct from those described above. The seedling of *Asarum Canadense* L. has a long primary root, sparingly ramified, an erect hypocotyl, and two epigeic, long-petioled cotyledons with the blades oblong-ovate; the cotyledons are held in an erect position, and the venation of the blade is distinctly palmate. The plumule may develop a green leaf in the first season, but generally it stays dormant until the succeeding spring. The first rejuvenation depends upon the appearance of cotyledonary buds, and the development of a scale-leaf preceding a green with the blade reni-

form. In the third year the primary root still persists, and the short, erect stem bears now two scale-leaves and one green; at the same time the cotyledonary buds are still dormant, and a bud has also appeared in the axil of the scale-leaf of the previous year. For a few years the direction of the stem remains vertical, and the primary root persists, but afterwards, when the secondary roots begin to develop, the stem becomes horizontal, and the primary root dies off. As already indicated by the young plant there is a regular alternation of scale-like and green leaves, which becomes continued in the mature plant. The stage of rejuvenation in the mature plant shows us three scale-leaves preceding two green ones surrounding the single, terminal flower. Moreover some lateral branches become developed from the axils of the scale-leaves from the year previous, while only one of the green leaves, the lower, subtends a bud; a long internode is visible between the last scale-leaf and the first green one, while all the other internodes are very short. From the seedling stage until the first flowering the axis represents a monopodium, but after that time the bud in the axil of the green leaf grows out into a flowering shoot of the same structure as the mother-axis, and a sympodium becomes formed. Several of the buds in the axils of the scale leaves grow out at the same time, thus a mature specimen may show an amply ramified stem, representing the growth of several years. In *Asarum Virginicum* L. and *A. arifolium* Michx. only one green leaf is developed each year, preceded by two scale-like. According to Eichler the European *Asarum Europaeum* L. shows the same composition of the shoot as *A. Canadense*, but the leaves are evergreen (as in *A. Virginicum* and *A. arifolium*), and the bud, which continues the direction of the mother-shoot, is situated in the axil of the upper green leaf.

Several other examples might be mentioned, especially from the suffrutescent, for instance: *Mitchella, Vaccinium Oxycoccos* L., *Arctostaphylos, Epigaea, Chiogenes, Linnaea, Pyxidanthera* etc. Among the Monocotyledones creeping plants are represented by several genera: *Eragrostis* (*E. reptans* Nees), *Catabrosa* (*C. aquatica* L.) Beauv. *Cynodon, Buchloe, Mayaca, Commelina, Heteranthera*, etc.

The rhizomes, the pseudo-rhizomes, the tubers, the bulbs, the stolons, the runners and finally the creeping stems, all of these structures indicate the perennial habit, taking an active part in the hibernation and rejuvenation of the plants. As storage-organs and at the same time representing an important means of distributing the plants, the rhizomes are well comparable to the tuberiferous or bulbiferous stolons; the runners perform the same function as the creeping stems. They are widely distributed among the plants, and to a very different extent. Moreover they are not connected with any particular type of floral shoots, as represented in perennial herbs. The very unlike distribution of these structures among the species themselves points towards the probability that they are fixed characters rather than epharmonic. For when we compare the actual conditions of the environment, these are identical and common to numerous other plants, even closely allied species, lacking such structures. Some indication of epharmonism seems to depend on the almost complete absence of bulbs and runners from the arctic and alpine regions. The nature of the environment must be decisive in this particular case. The geographical distribution of plants with bulbs or runners does not cover these regions. It seems also remarkable, for instance, that the sciaphilous plant-associations comprise the most extreme types of vegetative structures, with almost the only exclusion of the annuals. Moreover, we must remember that some very peculiar structures are retained by the mature plants. Some of these structures are undoubtedly fixed, since they appear so very plainly at the seedling-stage, just before the first hibernation, a period that hardly might have any influence upon the future habit of the plant, from an epharmonic point of view. We have seen that in certain species of the *Labiatae* stolons with or without tubers are developed from the cotyledonary buds before the first hibernation; still some of the species are closely related, and occupy the same soil. The species of *Hydrocotyle* described above are also interesting from this point of view.

With regard to the root-system the mature plants often retain the primary structure, that of the seedling. The fibrous, secondary roots replacing the primary, as shown al-

ready at the seedling stage of *Ranunuculus abortivus* is a structure common to many Dicotyledones. The primary root developed as a storage-root very frequently persists as such through the whole life of the plant as for instance in *Claytonia Virginica* L., *C. Caroliniana* Michx., *C. lanceolata* Pursh, *C. magarrhiza* Parry, *C. arctica* Adams, *Panax quinquefolium*, *P. trifolium*, *Erigenia*, *Ipomaea pandurata*, *I. leptophylla*, *Phytolacca decandra*, *Chenopodium ambrosioides*, etc. In *Anemonella thalictroides* (L.) Spach the primary root shows already at the seedling-stage a distinct increase in thickness, forming a fusiform tuber, and it remains active until the next season, when it becomes replaced by a secondary root of same thickness; in mature plants the root-system consists of a cluster of tuberous roots. *Ludvigia alternifolia* shows the same structure of the root-system, and beginning already at the seedling-stage. The tap-root in *Aconitum uncinatum* L. persists as such until the flowering stage; when the fruits have matured, the individual dies off, except some short, thick stolons developed from the axils of the basal leaves. These stolons are terminated by a large, vertical bud with a tap-root of the same structure as that of the mother-plant, and new individuals are produced during the succeeding spring. In *Scrophularia nodosa* L. var. *Americana* Michx. the hibernating stage of the mature plant shows several long, swollen, more or less fusiform roots with slender apices, and with several lateral, thick branches; these roots grow in a horizontal direction, and are white, almost transparent. There is no rhizome s. s., but the basal internodes of the aerial stem persist, and some axillary buds winter over to develop into aerial shoots in the succeeding year.

Archemora rigida DC., of which the primary root shows a distinct increase in thickness before the first hibernation, retains this structure in most of the secondary roots during the succeeding years. An immature specimen, purely vegetative, and in its fourth or fifth year, has no rhizome in the stricter sense of the word, but only some very short internodes with remnants of leaves. At the stage of rejuvenation the root-system consists of two sets of secondary roots: several very long and slender proceeding from the very base of the shoot, and beneath these four to five thick, fusiform,

all of a white color. Most of the long, slender roots will increase in thickness during the summer, and become storage-roots with the apical portion dying off gradually. They will thus attain the same structure as the thick, fusiform, which had hibernated. When the plant has reached maturity, the aerial stem dies down to the ground during the fall, leaving only a large bud to hibernate, and a cluster of fusiform roots (Fig. 13). *Cicuta maculata* L. shows the same structure of the seedling as *Archemora,* and the same development of large, fusiform roots in older specimens. The stage of rejuvenation of the mature plant (Fig. 14) shows many long, slender roots above the fusiform, which have hibernated. When the fruits have matured, the stem withers, leaving a small bud in the axil of the basal leaves to winter over. But beside this little bud, there are two others, much larger, situated at some distance below. These large buds have a thick, short axis of several internodes, and provided with a root-system of their own: four thick, fusiform roots (Fig. 15). The destination of these buds is to develop new individuals, when they become detached from the mother plant during the fall; figure 15 shows the hibernating stage of one of these buds, which had become detached. The small bud, mentioned above, will evidently develop into a new shoot, but remain in connection with the old stem and the roots, several of which were still fresh and active. A similar structure has been described by Warming (1884) as characteristic of *Anthriscus silvestris;* in this plant, however, the primary root becomes a large taproot, and persists as such. The individual dies generally after the first flowering, but vegetative reproduction becomes effected by means of several basal buds, which drop off and develop new individuals. While still connected with the mother-plant these buds are provided with one or two thick storage-roots, exactly as in *Cicuta.*

Among the *Compositae* we observe a tuberous root and the development of basal, axillary buds in *Prenanthes alba* L., but we have not, so far, been able to find the seedlings. In young, purely vegetative specimens, the root is very thick and branched, the branches short, and each extended into mostly two long, almost filiform apices. At this stage only a

few green leaves are developed, besides some scale-like, and some basal shoots are already to be seen at the very base of the root. These shoots consist of one or two scale-leaves beside some few green ones, but with the blades ovate, and not lobed as the typical foliage. Moreover, each shoot has a long, thin root, and becomes detached from the mother-plant in the course of the summer. Individuals developed from this type of buds are numerous, and they represent an important means of vegetative reproduction. The long, slender root withers almost completely, leaving only the basal portion to hibernate, which at that time has already increased considerably in thickness and attained approximately the same shape as the root of the mother-plant, but in a smaller scale. We have thus in *Cicuta, Anthriscus* and *Prenanthes* a type of vegetative reproduction, where basal shoots become detached from the mother-plant, and produce new individuals; this type of reproduction is connected with a root-system of considerable size, at least so far as concerns the genera mentioned.

With respect to the Monotyledones the root-system shows but little of interest in the mature plants, since no increase in thickness takes place. In some of the *Orchidaceae*, notably our species of *Orchis* and *Platanthera* the root beneath the hibernating bud is quite thick, and more so than the others. This depends on its anatomical structure, which shows several central cylinders, instead of only one as in the other roots. Relatively thick storage-roots are exhibited by several species of *Commelina*, for instance *C. Virginica* L. and *C. erecta* L. the rhizomes of which are very short, condensed. In *Tradescantia rosea* Vent. and *T. pinetorum* Greene the rhizomes are long and horizontal, bearing two to three thick roots at each node; in the latter species these roots vary from oblong to fusiform terminated by a long, slender apex. Similar fusiform storage-roots occur also in *Weldenia candida* Schult. fil., proceeding from the basal nodes of the short, vertical rhizome. The thickness of the root of these *Commelinaceae* depends only upon the large number of parenchymatic strata, notably in the cortex. In *Uvularia perfoliata* the very short, subterranean stem bears a facicle of relatively thick roots, while in *Oakesia sessilifolia* with

the horizontally creeping rhizome the roots are more slender.

In comparing the root-structure represented by the perennial herbs at the stage of maturity, it is interesting to notice that several, very distinct types occur within the same genus, as for instance in *Claytonia, Panax, Oxalis, etc.*, in accordance with the structure of the subterranean stem, however. For in Claytonia the large-rooted species have no rhizomes, while in the species with fibrous roots, *C. parvifolia* Moc., and *C. asarifolia* Bong. a rhizome is well represented, vertical in the former, horizontally creeping in the latter. Only the bulbous species of *Oxalis* have a typical tap-root, and, as mentioned above, *O. violacea* multiplies to a great extent by means of bulbiferous stolons. There is sometimes a well marked correlation between the structure of the subterranean stem and the root-system viz., creeping rhizomes, and stolons have generally slender roots, while most of the short, vertical rhizomes, and several pseudo-rhizomes bear roots of the type "storage-roots." But with regard to the environment none of these root-structures appear to be dependent on any particular kind of soil; large-rooted species may be found in woods, fields, bogs, etc., but mostly in the low-lands. *Claytonia megarrhiza, Calandrinia pygmaea* and *Rhodiola*, are known from the alpine regions; *Claytonia arctica* Adams and *Rhodiola rosea* L. from the arctic.

Regarding the development of buds as a means of vegetative reproduction, distinction must be drawn between those which develop into shoots before they become detached from the mother-plant, and those, which in the shape of small tubers or bulbs fall off, and do not develop into new individuals until the succeeding spring. The first type is represented by *Archemora, Anthriscus* and *Prenanthes*, as described above. In these plants the buds have begun to develop leaves and are provided with roots before they become detached. The second type, tubers or bulbs, occurs in *Dentaria tenella* Pursh., *Cicuta bulbifera* L., *Polygonum Macounii* Small, *P. viviparum* L. (tubers); in *Saxifraga cernua* L., *S. granulata* L., *S. stellaris* L. var. *comosa* Poir., and *Claytonia parvifolia* Moc. (bulbs). In *Dentaria tennella* small tubers, single or in clusters of two to four, are developed along the subterranean portion of the long petioles of

the basal leaves, as well as in the axils of the cauline. *Cicuta bulbifera* has no bulbs, but tubers, consisting of two internodes, in the axils of the upper-stem-leaves. Similar tubers occur in the inflorescence of the two species of *Polygonum*. Small bulbs are as mentioned above,, known from *Saxifraga cernua* L., *S. bulbifera* L. and *S. granulata* L., where they occur at the base of the aerial shoot, besides in the axils of the bracts of the inflorescence; in *Saxifraga stellata* L. var. *comosa* Poir. nearly all the flowers are replaced by bulblets. Finally in *Claytonia parvifolia* Moc. several of the cauline leaves subtend bulblets. These buds, however, whether developed into shoots before becoming detached, or representing small tubers or bulbs to hibernate before developing any further these are axillary with the only exception of the tubers upon the petioles in *Dentaria*.

A very different type is the adventitious, where the buds occur notably upon the roots, seldom upon the hypocotyl, and very seldom upon the leaves. Of these the root-shoots are known from many trees and shrubs, but only from a small number of the herbs. Among the herbs *Cirsium arvense* (L.) Scop., and *Rumex Acetosella* L. are examples well known. While root-shoots generally substitute stolons and rhizomes, we observed a combination of both in *Lupinus perennis* L., *Pyrola aphylla* Sm., *Chimaphila umbellata* (L.) Nutt., and *Ch. maculata* (L.) Pursh. It is not uncommon to observe that the production of root-shoots in abundance results in the almost complete non-development of germinative seeds as for instance in *Convolvulus spithamaeus* L., and various species of *Apocynum, Asclepias*, etc. On the other hand, *Rhexia Mariana* L. and *Rh. Virginica* L., as described above depend solely upon root-shoots, so far as concerns their vegetatiye reproduction. We might also call attention to *Strophostyles umbellata* (Muehl.) Britton, of which the root-system remains active and produces numerous shoots in the third year after germination, while the aerial shoots die off completely in the course of the second year.

Adventitious buds upon the hypocotyl are known from only a few North American genera: *Linum, Hypericum* and *Linaria*. In *Linum* and *Hypericum* the development of shoots in this manner enables the plant to persist for several years

instead of but one, the species being typically annuals. With reference to the development of buds upon leaves *Tellima grandiflora* Dougl., *Cardamine pratensis* L., several species of *Drosera,* and *Malaxis paludosa* (L.) Sw. are examples well known.

These structures constitute the most important means by which the herbs become enabled to persist as perennials. They are very well expressed in the mature plants, but the real nature of some of these structures may not be understood unless we know their origin from the seedling-stage. In many instances the distinction between rhizomes and stolons cannot be drawn unless we know with certainty that the former represent the primary axis from the very beginning, and the latter branches of second order. We have seen how the plumule, sometimes in connection with the hypocotyl, may develop into a horizontally creeping rhizome as in *Podophyllum, Sanguinaria, Heuchera, Cimicifuga, Viola, Dioscorea,* etc., and remaining purely vegetative for several years. We have also seen how the plumule may develop into an aerial shoot, vegetative as in *Phryma, Ludvigia, Baptisia,* floral in *Chenopodium ambrosioides,* and that the basal internodes of this shoot persist and, with the hypocotyl and root, form a pseudo-rhizome, a complex of stem-bases. Furthermore the plumule may develop into an aerial shoot, of which the cotyledonary buds grow out as stolons at the expense of the entire primary axis, the seedling; this structure occurs, as described above, in several *Labiatae* (*Lycopus, Scutellaria*), in *Hydrocotyle Americana, Circaea, Trientalis,* etc.; in *Triadenum* we have seen that these cotyledonary shoots have tuberous internodes, thus reminding more of a rhizome than a stolon. The stage of hibernation of the cotyledonary shoots, tubers (*Labiatae,* etc.), tuberous branches (*Triadenum*) might thus be mistaken for axes of primary order, although they are strictly lateral. The development of the plumule into a rosette of leaves, for several years preceeding the appearance of an erect, floral shoot as in *Heuchera* and *Cimicifuga,* recurs in *Claytonia,* as mentioned above. But these structures are very different, however. For in *Claytonia* the primary axis remains purely vegetative through the whole life of the plant, representing a monopodium,

while in *Heuchera* the ramification becomes sympodial after the appearance of the first inflorescense. It is interesting to notice that in several of the acaulescent species of *Viola, V. papilionacea* for instance, a similar monopodium is represented, and beginning already at the seedling-stage; in these *Violae,* however, the primary axis increases in length, forming a horizontal rhizome, but with the leaves crowded in the manner of a rosette, and with the primary root not persistent. The different growth of the plumule is altogether of significant importance to the future habit of the plant, and as we have seen above, there is frequently a certain correlation to be observed between the structure of the main, the primary, axis and the root-system. Creeping rhizomes have generally slender roots, at least in the Dicotyledones; but in *Tradescantia rosea* and *T. pinetorum* the long, creeping rhizomes bear thick roots, in the latter even fusiform. Large storage-roots are generally characteristic of species with pseudo-rhizomes (*Asclepias, Dahlia, Panax*), or with very short, erect rhizomes s. s. as for instance *Archemora, Cicuta, Erigenia, Aconitum, Uvularia, Orchis, Platanthera,* etc.; they occur also in certain species of *Ludvigia, Oenothera, Oxalis, Claytonia,* and in *Anemonella,* where the subterranean stem is very poorly represented, by the hypocotyl alone in *Ludvigia* and *Oenothera.* We might also call attention to the profuse development of root-shoots in plants that lack the power to spread by means of rhizomes or stolons, but as stated above some few exceptions are known, for instance *Pyrola, Chimaphila* and *Lupinus* in which stolons are well exemplified.

When, on the other hand, the plumule does not become the center of any subterranean structure, but simply develops into an aerial shoot, the perennial habit then becomes established by means of runners (*Antennaria, Saxifraga flagellaris*), or by the shoot itself becoming a creeping plant (*Glechoma, Ranunculus Cymbalaria*). These two structures substitute stolons, but the runners are generally terminated by rosettes of leaves. We have described the singular structure shown by the runners in *Potentilla Canadensis,* where some of the rosettes hibernate in the shape of tubers. This *Potentilla* does not, however, belong to this category of

plants, since it has a distinct rhizome, and the tubers being axillary, not terminal.

In several annual species the habit may become changed to perennial, but not by means of runners or by the stem becoming creeping. In *Linum Virginianum* L. numerous small, leafy shoots become developed at the base of the fruit-bearing shoot; they are mostly adventitious, and several are developed from the hypocotyl. The hibernating stage thus represents a stem-base with a small rosette of green shoots, some of which may develop into floral shoots in the succeeding spring. *Hypericum mutilum* L. (Fig. 46), *H. Canadense* L. and *H. nudicaule* Walt. show a similar structure with basal shoots, frequently branching. We have thus in these species of *Linum* and *Hypericum* a pseudo-rhizome in its simplest form. As mentioned above *Strophostyles umbellata* may persist for three years, the plumule developing into a vegetative shoot in the first year, the cotyledonary buds into floral shoots in the second, while the persisting root-system produces numerous shoots in the third year. *Amphicarpaea monoica* is an annual, although the cotyledonary buds develop into subterranean, branched shoots, showing the structure of stolons, but being terminated by inflorescences of cleistogamous flowers. But in *Cyperus flavescens* L., as it occurs in the vicinity, true stolons are sometimes developed, enabling the plant to persist for at least another year.

These are thus the most important structures, by which the herbs become enabled to persist as perennials. They are structures of very different origin, and they appear in a number of modifications in accordance with the requirements of the plants for existence and multiplication. Likewise the germination, the hibernation and rejuvenation often reveal structures that deviate remarkably from those possessed by genera or species closely allied. The influence of the environment plays, of course, a rôle of great importance, and many of these structures may be readily recognized as epharmonic. But there are others, which are undoubtedly fixed, those that accompany the plant, wherever it grows. The organization, or we might say the individuality, of the plants is the most potent factor, however. It sometimes acts independently of relationship, but in conformity with the re-

quirements of the plant and its plasticity. It seems as if we cannot in any other way explain the occurrence of certain peculiar structures in plants representing a very natural assemblage of genera or species and otherwise possessing all the characteristics of relationship. We have seen how differently the seedlings prepare for the first hibernation, and the complex of structures that evolve in the course of rejuvenation. We need only to remind of the genus *Viola*, how the first hibernation indicates the singular bulbous structure of the rhizome in *V. papilionacea* Pursh and its allies, so very distinct from all the others. From this particular point of view *Viola* is especially interesting. The floral structure is so uniform that Gingius and De Candolle only recognized three sections based upon the direction of the petals in the European species, while Brainerd (Gray's Manual) divided 45 North American species into seven sections according to the structure of the style. But if we combine the floral structure with the habit in the European and North American species (incl. the Pacific States) the number of sections may be increased to eleven. The habit is very characteristic. Most of the caulescent species are perennial with pseudo-rhizomes, runners or stolons, and several show a monopodial growth. In the acaulescent we have the bulbous rhizome represented by the *V. papilionacea* group (*V. emarginata* Le Conte, *V. Macounii* Greene, *V. affinis* Le Conte etc.), beside some few European: *V. umbrosa* Fr., *V. sciaphila* Koch, *V. cyanea* Celak., etc. The other acaulescent species have creeping, very slender rhizomes, stolons or runners, except *V. pedata* L., *V. pedatifida* Don and *V. pinnata* L. in which the stout rhizome is vertical. We have thus in *Viola* an excellent example of a genus with a very uniform structure of the flower and fruit, but with the vegetative reproduction effected in a very different way. In certain species the epharmonic characters are shown by the leaves, notably the ample blades of the aestival foliage of the more or less sciaphilous species and perhaps by the deeply cut leaves of the species in the open. But with reference to the distribution of rhizomes, stolons and runners, these are frequently represented by species growing associated with each other, and may therefore not be regarded as epharmonic. The bulbous rhizome in

Viola is somewhat unique, and in no connection with the other types of stem-structures in the genus. It seems strange that the nearest analogy of this bulb-like structure must be sought in *Dentaria* and *Lithophragma*. In the species of the former tuberous and bulb-like rhizomes are the typical and the only ones represented by the genus.

We might also mention the genus *Stellaria*. In most of the species the vegetative reproduction is effected by means of stolons, but, as described above, *Stellaria pubera* multiplies by aerial shoots becoming runner-like, besides that a pseudo-rhizome becomes developed. In *Stellaria Jamesii* Torr., on the other hand, a typical, creeping rhizome is developed, with the internodes partly swollen and tuberous, resembling sometimes the stolons of *Apios*. Moreover in *Stellaria bulbosa* Wulf., from Austria, the very weak, ascending shoots have a fusiform, fleshy tap-root at each of the subterranean nodes.

Finally we have in *Claytonia* a genus of about only thirty species with a habit so different, that no less than five sections are necessary to combine these in a systematic manner, the distinction depending mainly on purely vegetative characters. A large, persistent primary root is characteristic of *Euclaytonia*, beside the monopodial growth of the shoot. In *Limnia* the species are either annual, or perennial with a horizontally creeping rhizome or with stolons; *Alsinastrum* has bulbiferous stolons; *Naiocrene* has a short, vertical monopodial rhizome, and bulblets are developed in the axils of the cauline leaves; in *Montiastrum* all the species are annual with the leaves broadly ovate to linear. With the exception of some species of *Montiastrum*, where the petals are unequal, and some of the stamens suppressed, the floral structure is very uniform in the genus.

The purely vegetative characters thus constitute a great complex of structures, sometimes very unequally distributed in the natural families of plants. The systematic position of the genus among the more evolute or lesser developed types plays no rôle of importance as to the behavior of the plant during the stage of hibernation and rejuvenation. Combination of structures, cauline or foliar, are not always necessary to the actual outcome of the first hibernation—a lateral root with a bud may be sufficient, as we have seen in *Rhexia*.

BIBLIOGRAPHY.

Braun, Alexander. Betrachtungen ueber die Erscheinung der Verjüngung in der Natur, Leipzig 1851.

Henslow, G. The origin of plant-structures. London 1895.

Irmisch, Th. Beitrag zur Naturgeschichte des *Cirsium arvense*. Zeitschr. f. ges. Naturwiss. Vol. 1, 1853.

Same. Zur Naturgeschichte von *Melittis Melissophyllum*. Bot. Zeit. 1858.

Same. Ueber einige Fumariaceen. Abhdl. Naturf. Ges. Halle. Vol. 6. 1862.

Same. Beiträge zur vergleichenden Morphologie der Pflanzen. 1-4 VI. Halle 1854-1879.

Nilsson, N. Hj. Dikotyla jordstammar. Acta Univ. Lund. Vol. 19. 1882-1883. Lund 1882-1883.

Warming, Eug. Om. Skudbygning, Overvintring og Foryngelse. Naturhist. For. Festskr. Kjoebenhavn 1884.

Same. Om Jordudloebere. Kgl. Danske Vidensk. Skr. Koebenhavn 1918.

Same. Oekologiens Grundformer ibidem. Koebenhavn 1923.

Species of the following genera of North American plants have been described morphologically and anatomically by the writer in the periodicals as follow:

American Journal of Science. Vol. 9. 1900. *Pogonia*—Vol. II. 1901. *Erigenia*—Vol. 16. 1903. *Triadenum*—Vol. 18. 1904. *Orchideae*—Vol 19. 1905. *Anemiopsis*—Vol. 20. 1905. *Croomia*—Vol. 22. 1906. *Ceanothus*—Vol. 24. 1907. *Anemonella*—Vol. 25. 1908. *Isopyrum*—Vol. 25. 1908. *Stellaria*—Vol. 31. 1911. *Mollugo*—Vol. 50. 1921. *Chionophila*—Vol 2. (new series) 1921. *Dirca*—Vol. 6. 1923. *Chenopodium*—Vol. 2. *mum*—Vol 8. 1924. *Ilysanthes, Scrophularia, Linaria.*

On the vitality of some annual plants ibidem Vol. 42. 1891.

Notes on *Hydrocotyle Americana*. Proceed. U. S. Nat. Mus. Vol. XI. Washington 1888.

Contributions to the knowledge of the germination of some North American plants. Mem. Torrey Bot. Club Vol. 2. New York, 1891.

Observations on seedlings of North American phaenogamous plants. The Ottawa Naturalist Vol. 22. 1908.

Biological notes on Canadian species of *Viola* ibidem Vol. 17. 1903.

Notes on *Uvularia, Oakesia, Diclytra* and *Krigia*. Bull. Torrey Bot. Club Vol. 18. 1891.

Botanical Gazette. Chicago. Vol. 25, 1898. *Pyrola*—Vol. 27. 1899. *Podophyllum*—Vol. 43. 1907. *Rubiaceae*—Vol. 43. 1907. *Ruellia,*

Dianthera—Vol. 44. 1907. *Rhexia*—Vol. 56. 1913. *Phryma.*

Comandra umbellata (L.) Nutt. The American Midland Naturalist Vol. 9. 1924.

Apios tuberosa Moench. ibiden 1924.

Claytonia Gronov. Mem. Nat. Acad. of Sc. Vol. 10. Washington 1905.

Commelinaceae. ibidem Vol. 10, 1906.

The vegetation of the alpine region of the Rocky Mountains in Colorado. ibidem Vol. 19. 1923.

Types of *Claytonia.* Mindeskrift f. Japetus Steenstrup. Koebenhavn 1913.

Medicinal plants of North America. Merck's Report. New York. 1907-1917. References only given to the plants mentioned in this paper; 1907: *Aconitum, Caulophyllum, Jeffersonia, Cunila, Erythronium, Podophyllum.* 1908: *Medeola, Sanguinaria, Cimicifuga, Baptisia.* 1909: *Cicuta, Collinsonia, Chimaphila.* 1910. *Aletris, Glechoma, Apocynum.* 1911: *Arisaema, Asarum, Scutellaria.* 1912: *Lycopus, Chenopodium, Heuchera.* 1913: *Leptandra, Corallorhiza, Hydrastis, Dioscorea,* 1914: *Achillea, Chamaelirium, Hepatica.* 1915: *Maranta, Petiveria.* 1916: *Aralia, Panax.*

THE FOSSIL FLORA OF THE VICINITY OF COLD SPRING HARBOR.

BACILLARIOPHYTA*

ACHNANTHOIDEAE

Campyloneis Grevillei (W. Sm) Grun. Lloyd Neck, L. I.—H. Ries.
Cocconeis pediculus Ehr. Lloyd Neck, L.I.—H. Ries.
Cocconeis placentula Ehr. Lloyd Neck, L. I.—H. Ries.

BIDDULPHIOIDEAE.

Triceratium trifoliatum. Lloyd Neck, L. I.—H. Ries.

DISCOIDEAE.

Melosira granulata (Ehrb.) Kuetz. Lloyd Neck, L. I.—H. Ries.
Stephanodiscus niagarae Ehr. Lloyd Neck, L. I.—H. Ries.

FRAGILLAROIDEAE.

Diatoma hiemale K. B. Lloyd Neck, L. I.—H. Ries.
Eunotia monodon Ehr. Lloyd Neck, L. I.—H. Ries.
Fragillaria construans. Gruns.
Synedra affinis Kuetz. Lloyd Neck, L. I.—H. Ries.

NAVICULOIDEAE.

Cymbella cuspidata Kuetz. Lloyd Neck, L. I.—H. Ries.
Cymbella delicatula Kuetz. Lloyd Neck, L. I.—H. Ries.
Encyonema ventricosum Kuetz. Lloyd Neck, L. I.—H. Ries.
Epithema turgida (Ehr.) Kuetz. Lloyd Neck, L. I.—H. Ries.
Gomphonema capitatum Ehrb. Lloyd Neck, L. I.—H. Ries.
Navicula cucconeiformis Greg. Lloyd Neck, L. I.—H. Ries.
Navicula lata Breb. Lloyd Neck, L. I.—H. Ries.
Navicula major Kutz. Lloyd Neck, L. I.—H. Ries.
Navicula varians Grey. Lloyd Neck, L. I.—H. Ries.

---

* Compiled from "Microorganisms in the Clays of N. Y." H. Ries, Trans. N. Y. Acad. Science Vol. 13, 1894, p. 165-69.

Navicula viridis Kuetz. Lloyd Neck, L. I.—H. Ries.
Stauroneis phaenecenteron Ehrb. Lloyd Neck, L. I.—H. Ries.

PTERIDOPHYTA*

MARSILIACEAE.

Marsilea Andersoni Hollick. Manhasset—A. E. Anderson.

POLYPODIACEAE.

Onoclea inquirenda (Hollick) n. comb. Glen Cove, Little Neck, Northport Harbor, L. I.—A. Hollick.

SPERMATOPHYTA.

GYMNOSPERMAE.

ARAUCARINAE.

Androvettia statenensis Hollick and Jeffrey, Androvette pit, Kreischerville, Staten Island, E. C. Jeffrey and Hollick.

Anomaspis hispida Hollick and Jeffrey. Androvette pit, Kreischerville, Staten Island—E. Jeffrey and Hollick.

Anomaspis tuberculata Hollick and Jeffrey. Androvette pit, Kreischerville, Staten Island,—E. Jeffrey and A. Hollick.

Araucariopitys americana Jeffrey. Androvette pit, Kreischerville, Staten Island.—E. C. Jeffred and A. Hollick.

Araucarioxylon noveboracense Hollick and Jeffrey. Drummond pit, Kreischerville, Staten Island.—E. C. Jeffrey and A. Hollick.

Brachyoxylon notabile Hollick and Jeffrey. Androvette pit, Kreischerville, Staten Island. A. Hollick and E. C. Jeffrey.

Dactylolepis crytomeroides Hollick and Jeffrey. Androvette pit, Kreischerville, Staten Island. E. C. Jeffrey and A. Hollick.

Eugeinitzia proxima Hollick and Jeffrey. Androvette pit, Kreischerville, Staten Island. E. C. Jeffrey and A. Hollick.

---

* This list is compiled from the following publications "The Cretaceous Flora of Southern New York and New England." A. Hollick. Mon. 50: U. S. G. S. 1906; Additions to the Paleobotany of the Cretaceous formation on Long Island No. III. A. Hollick. Bull. N. Y. Bot. Garden. 8:154-170; Studies of Cretaceous Coniferous Remains from Kreischerville, N. Y. Mem. N. Y. Bot. Garden 3:1-76. Species cited in these publications as occurring on Martha's Vineyard are omitted.

Geinitzia sp. Androvette pit. Kreischerville, Staten Island.—E. C. Jeffrey and A. Hollick.

Geinitzia Reichenbachii (Geinitz) Hollick and Jeffrey. Androvette pit, Kreischerville, Staten Island—A. Hollick.

Prodammara speciosa Hollick and Jeffrey. Androvette pit, Staten Island.—E.C. Jeffrey and A. Hollick.

Pseudogeinitzia sequoiiformis Hollick and Jeffrey. Androvette pit, Staten Island.—E.C. Jeffrey and A. Hollick.

Raritania gracilis (Newberry) Hollick and Jeffrey. Androvette pit. Staten Island.—E. C. Jeffrey and A. Hollick.

Strobilites Davisii Hollick and Jeffrey. Drummond pit, Kreischerville, Staten Island.—W. T. Davis.

Strobilites sp. Androvette pit. Kreischerville, Staten Island.—A. Hollick.

Thuites sp. Androvette pit, Kreischerville, Staten Island.—E.C. Jeffrey, A. Hollick.

Coniferous Remains of Undetermined Relationship.

Cupressinoxylon sp. Drummond pit, Kreischerville, Staten Island.—E.C. Jeffrey, A. Hollick.

Czekanowskia capillaris Newberry. Androvette pit, Kreischerville, Staten Island.—E. C. Jeffrey, A. Hollick.

Strobilites microsporophorus Hollick and Jeffrey. Androvette pit, Kreischerville, Staten Island.—E. C. Jeffrey and A. Hollick.

CYCADACEAE.

Podozamites lanceolatus (Lindley and Hutton) Schimper. Glen Cove, L. I. Kings Gravel Pit, Roslyn, N. Y.—A. Hollick.

Podozamites sp. Glen Cove, L. I.—A. Hollick.

Protophyllocadus subintegrifolius (Lesq.) Berry. Black Rock Point, Block Island; Tottenville, Staten Island; Princess Bay, Staten Island.—A. Hollick.

Williamsonia problematica (Newberry) Ward. Glen Cove, N. Y.—A. Hollick, E. Berry, A. B. Bibbins.

FAMILY PINACEAE.

Brachyphyllum macrocarpon Newberry. Little Neck, Northpoint Harbor, Northport Harbor, L. I. A. Hollick; Drummond pit, Kreischerville, Staten Island, J. H. Dunnigan; Androvette pit, Kreischerville, S. C. Jeffrey, A. Hollick.

Cyparissidium gracile (Heer.) Heer. Tottenville, Staten Island—A. Hollick.

Dammara borealis Heer. Glen Cove, L. I., Tottenville, Staten Island—A. Hollick.

Dammara minor Hollick. Balls Point, Black Island—A. Hollick.

Dammara, Northportensis Hollick. Little Neck, Northport Harbor, L. I.—A. Hollick.

Frenelopsis Hoheneggeri (Ettinghausen) Schenck? Center Island, Oyster Bay.—A. Hollick.

Juniperus hypnoides Heer. Kreischerville, Staten Island.—A. Hollick.

Moriconia cyclatoxon Debey and Ettinghausen. Black Rock Point, Block Island.—A. Hollick.

Pinus tetraphylla Jeffrey. Androvette pit, Kreischerville, Staten Island.—E. C. Jeffrey and A. Hollick.

Pinus triphylla Hollick and Jeffrey. Kreischerville, Staten Island, Old excavation south of Killmeyer's Hotel, and Androvette pit.—E.C.Jeffrey and A. Hollick.

Pinus quinquefolia Jeffrey and Hollick. Androvette pit, Staten Island. E. C. Jeffrey and A. Hollick.

Pitoxylon statenense Jeffrey and Chrysler. Drummond pit, Kreischerville, Staten Island.—E.C. Jeffrey and A. Hollick.

Prepinus statenensis Jeffrey. Androvette pit, Staten Island.—E.C. Jeffrey and A. Hollick.

Sequoia heterophylla Velenovsky. Kreischerville, Staten Island.—A. Hollick.

Sequoia reichenbachii (Geinitz) Heer. Kreischerville, Staten Island.—A. Hollick.

Sequoia sp. Glen Cove, L. I.—A. Hollick.

Widdringtonites Reichii (Ettinghausen) Heer. Androvette pit, Kreischerville, Staten Island.—A. Hollick.

Widdingtonites subtilis Heer. Black Rock Point, Block Island.—A. Hollick.

ANGIOSPERMAE.

Typha sp. Lloyd Neck, L. I.—David White.

POACEAE (*Graminaceae*)

Poacites sp. Glen Cove, L. I.—A. Hollick.

CYPERACEAE.

Cyperacites sp. Glen Cove, L. I.—A. Hollick.

LILIACEAE.

Majanthemophyllom pusillum Heer. Kreischerville, Staten Island.—A. Holilck.

SALICACEAE.

Populus (?) *apiculata* Newberry. Glen Cove, L. I.—David White.

Populus harkeriana Lesq. Tottenville, Staten Island.—A Hollick.

Aments of *Populus* sp. Glen Cove, L. I.—A. Hollick.

Salix cuneata Newberry. Kreischerville, Glen Cove, L. I.—David White.

Salix meekii Newberry. Arrochar, Staten Island.—A. Hollick.

Salix membranacea Newberry. Kreischerville, Staten Island.—A. Hollick.

Salix proteaefolia flexuosa (Newberry) Lesq. Sea Cliff, Long Island.—G. van Ingen.

Salix proteaefolia lanceolata Lesq. Black Rock Point, Block Island; Arrochar, Staten Island.—A. Hollick.

Salix purpuroides Hollick, Sea Cliff, L. I.—G. van Ingen.

Salix sp. Kreischerville, Staten Island.—A. Hollick.

MYRICACEAE.

Myrica Davisii, Hollick. Kreischerville. Staten Island.—W. T. Davis.

Myrica Hollicki Ward. Tottenville, Staten Island.—A. Hollick.

Myrica Zenkeri (Ettinghausen) Velenousky. Glen Cove, L. I.—David White.

JUGLANDACEAE.

Juglans arctica Heer. Tottenville and Staten Island, Black Rock Point, Block Island; King's Gravel Pit, Roslyn; Glen Cove, L. I.—A. Hollick.

Juglans crassipes Heer. King's Gravel Pit, Roslyn, L. I.—A. Hollick.

Juglans elongata Hollick. Sea Cliff, L. I.—G. Van Ingen.

FAGACEAE.

Quercus morrisoniana Lesq. Center Island, L. I.—A. Hollick.
Quercus (?) *novae-caesareae* Hollick. Tottenville, Staten Island—A. Hollick.

MORACEAE.

Kings Gravel Pit, Roslyn.

Ficus atavina Heer. Glen Cove, L. I.—A. Hollick.
Ficus fracta Velenovsky. Oak Neck, L. I.—A. Hollick.
Ficus Krausiana Heer. Southeast Point, Block Island.—A. Hollick.
Ficus Krausiana var. *susibmilis* Hollick. Kings Gravel Pit, L. I.—A. Hollick.
Ficus myricoides Hollick. Glen Cove, L. I.—David White.
Ficus sapindifolia Hollick. Mott Point, Manhasset Neck, L. I. —A. E. Anderson.
Ficus willisiana Hollick. Sea Cliff, L. I., G. van Ingens' Glen Cove,—A. Hollick.
Ficus Woolsoni Newberry. Kreischerville, Tottenville, Staten Island, Glen Cove, L. I.—A. Hollick, E. W. Berry, A. Bibbins.

PROTEACEAE.

Banksites saportanus Velenovsky. Glen Cove, L. I.—A. Hollick.
Embothriopsis presagita Hollick. Glen Cove, L. I.—A. Hollick, E. W. Berry, A. Bibbins.
Proteoides daphnogenoides Heer. Sea Cliff, L. I.—G. van Ingen.

NYMPHACEAE.

Nelumbo Kempii (Hollick) Hollick. King's Gravel Pit, Roslyn; Glen Cove, L. I., A. Hollick; Manhasset Neck, L. I. —A. E. Anderson.

MENISPERMACEAE.

Cocculus minutes Hollick. Little Neck, Northport Harbor, L.I.—H. Ries.
Menispermites Brysoniana Hollick. Glen Cove, L. I.—A. Hollick.
Menispermites sp. Tottenville, Staten Island, Hollick.

MAGNOLIACEAE.

Magnolia alternans Heer. Elm Point, Great Neck, L. I. — Pollard.

Magnolia auriculata Newberry. Glen Cove, L. I.—A. Hollick.

Magnolia Capellinii Heer. Glen Cove, Center Island, L. I.— A. Hollick.

Magnolia glaucoides Newberry (?) Sea Cliff, L. I.—G. van Ingen.

Magnolia Isbergiana Heer. Glen Cove, L. I.—A. Hollick.

Magnolia longifolia Newberry. Tottenville, Staten Island.— A. Hollick.

Magnolia longipes Newb. King's Gravel Pit, Roslyn, Glen Cove, L. I.—A. Hollick, Dosoris Island, L. I.—B. Willis.

Magnolia speciosa Heer. Glen Cove, L. I.—A. Hollick.

Magnolia tenuifolia Lesq. Sea Cliff. G. van Ingen. Glen Cove—David White.

Magnolia Van Ingeni Hollick. King's Gravel Pit, Roslyn; Sea Cliff, L. I.—G. van Ingen.

Magnolia woodbridgensis Hollick. King's Gravel Pit, Roslyn; Balls Point, Block Island.—A. Hollick.

Liriodendron attenuatum Hollick Glen Cove, L.I.—A. Hollick.

Liriodendron oblongifolium Newberry, Glen Cove.—A. Hollick.

Liriodendron primaevum Newberry. Tottenville, Staten Island.—A. Hollick.

Liriodendropsis angustifolia Newberry. Glen Cove, L. I.—D. White.

Liriodendropsis constricta (Ward var.) Glen Cove, L. I.— A. Hollick.

Liriodendropsis retusa (Heer) Glen Cove, L. I.—A. Hollick.

Liriodendropsis simplex (Newberry) Newberry. Glen Cove, L. I.—David White and A. Hollick.

Liriondendropsis spectabilis Hollick. Glen Cove.—D. White and A. Hollick.

ANONACEAE.

Guatteria cretaceae Hollick. Glen Cove, L. I.—D. White.

LAURACEAE.

Cinnamomum crassipetiolatum Hollick. Glen Cove. L. I. — D. White.

Cinnamomum intermedium Newberry. Manhasset Neck, Glen Cove, Sea Cliff, L. I.—A. Hollick.

Cinnamomum membranaceum (Lesq) Hollick. Glen Cove, L. I.—A. Hollick.

Laurophyllum elegans n. s. Glen Cove, L. I.—A. Hollick.

Laurophyllum lanceolatum Newberry. Glen Cove, L. I.—A. Hollick, E. Berry, A. Bibbins.

Laurophyllum nervillosum Hollick. Tottenville, Staten Island. —A. Hollick.

Laurophyllum ocoteaoides Hollick. Glen Cove, L.I.—A. Hollick.

Laurus augusta Heer. Little Neck, Northport Harbor, L. I. —H. Ries.

Laurus antecedens Lesq. Glen Cove, L. I.—D. White.

Laurus Hollae Heer. Kreischerville, Staten Island.—A. Hollick.

Laurus nebrascensis (Lesq.) Lesq. Kreischerville, Tottenville, Staten Island.—A. Hollick.

Laurus Newberryana Hollick. Glen Cove, L. I.—A. Hollick.

Laurus plutonia Heer. King's Gravel Pit, Roslyn, Black Rock Point, Block Island, A. Hollick; Glen Cove, L.I., D. White; Sea Cliff, L.I., G. van Ingen.

Ocotea nassavensis Hollick. Glen Cove.—D. White.

Persea Valida Hollick. Glen Cove,—D. White.

Platanus aquehongensis Hollick. Richmond Valley, Staten Island.—Mesner.

Platanus (?) *Newberryana* Heer. Elm Point, Great Neck, L. I.—Pollard.

Platanus sp. Princess Bay, Staten Island.—A. Hollick.

Sassafras acutilobum Lesq. King's Gravel Pit, Roslyn, Glen Cove, L. I.—A. Hollick.

Sassafras hastatum Newberry. Glen Cove, L. I.—A. Hollick.

Sassafras progenitor Newberry. Oak Neck, L. I.—A. Hollick.

CAESALPINACEAE.

Cassia insularis Hollick. Glen Cove, L. I.—A. Hollick, E. Berry, A. Bibbins.

Liriodendropsis constricta (Ward) Hollick. Glen Cove, L. I. A. Hollick.

Liriodendropsis gimplex (Newberry) Newberry. King's Gravel Pit. Roslyn, L. I.

Hymenaea dakotana Lesq. Sea Cliff, G. van Ingen. Lloyd Neck — A. Hollick.

PAPILIONACEAE.

Colutea primordialis Heer. Eaton Neck, L. I.—A. Hollick.
Dalbergia hyperborea Heer. Tottenville, Staten Island—A. Hollick.
Phaseolites elegans Hollick. Brooklyn, L. I.—Hollick.
Phaseolites manhassettensis Hollick. Manhasset Neck, L. I. —A. E. Anderson.

OTHER LEGUMINOSAE.

Leguminosites convolutus Lesq. Glen Cove.—A. Hollick.
Leguminosites constrictus Lesq. Oak Neck, L. I.—A. Hollick.
Leguminosites coronilloides Heer. Kreischerville, Staten Island.—A. Hollick.

ANACARDIACEAE.

Pistacia aquebongensis Hollick. Tottenville, Staten Island. —A. Hollick.
Rhus cretacea Heer I. Glen Cove, L. I.—D. White.

CELASTRACEAE.

Celastrophyllum crassipes Lesquereux (?) King's Gravel Pit, Roslyn, New York.—A. Hollick.
Celastrus arctica Heer. Little Neck. (Northport Harbor) L. I.—A. Hollick.
Elaeodendron sp. Glen Cove, L. I.—A. Hollick.

ACERACEAE.

Acer minutum Hollick. Tottenville, Staten Island.—A. Hollick.

SAPINDACEAE.

Sapindus apiculatus Velenovsky, Glen Cove, L. I.—D. White.
Sapindus imperfectus Hollick. Manhasset Neck, L. I.—A.E. Anderson.
Sapindus morrisoni Lesq. Glen Cove, L. I.—A. Hollick.

RHAMNACEAE.

Ceanothus constrictus Hollick. Glen Cove.—D. White.
Paliurus affinus Heer. Tottenville, Kreischerville, Staten Island.—A. Hollick.

Paliurus integrifolius Hollick. Oak Neck, Lloyd Neck, Glen Cove.—A. Hollick; Little Neck, Northport Harbor,— H. Ries.

Rhamnus acuta Heer. Lolyd Neck, L. I.—A. Hollick.

Zizyphus elegans Hollick, Glen Cove, L. I.—A. Hollick.

Zizyphus Lewisiana Hollick. Oak Neck, L. I.—A. Hollick.

Zizyphus oblongus Hollick. Glen Cove.—A. Hollick.

VITACEAE.

Cissites formosus Heer. Dosoris Island, Long Island. — B. Willis.

STERCULIACEAE.

Pterospermites modestus Lesq. Tottenville, Staten Island.—A. Hollick.

Sterculia sp. Tottenville, Staten Island.—A. Hollick.

MYRTACEAE.

Eucalyptus angustifolia Newberry. Little Neck, Northport Harbor, L. I.—A. Holilck.

Eucalyptus Geinitzii (Heer.) Heer. King's Gravel Pit, Roslyn; Glen Cove, L. I.—A. Hollick.

Eucalyptus Geinitzii propinqua Hollick. King's Gravel Pit, Roslyn, L. I.—A. Hollick.

Eucalyptus latifolia Hollick. Glen Cove, L. I.—A. Hollick.

Eucalyptus (?) *nervosa* Newberry. Sea Cliff, L. I.—G. van Ingen.

Myrtophyllum sapindoides Hollick. Glen Cove, L. I.—A. Hollick.

Myrtophyllum Warderi Lesq. Glen Cove, L. I.—A. Hollick.

ARALIACEAE.

Aralia nassauensis Hollick. Brooklyn, L. I.—J. C. Brevoort.

Aralia palmata Newberry. Tottenville, Staten Island, A. Hollick.

Aralia patens Newberry? Glen Cove, L. I.—A. Hollick.

Aralia Ravniana Heer. Tottenville, Staten Island.—A. Hollick.

Chondrophyllum orbiculatum Heer. Kreischerville, Staten Island.—A. Hollick.

OLEACEAE.

Ligustrum subtile Hollick. King's Gravel Pit, Roslyn, L. I.—A. Hollick.

ERICACEAE.

Andromeda latifolia Newberry. Oak Neck, L. I.—A. Hollick.
Andromeda Parlatorii Heer. Glen Cove, L. I.—A. Horlick.
Andromeda tenuinervis Lesq. Tottenville, Staten Island.—A. Hollick.
Kalmia brittoniana Hollick. Kreischerville, Staten Island.—A. Hollick.

MYRSINACEAE.

Myrsine borealis Heer. Glen Cove, L. I.—A. Hollick.
Myrsine elongata Newberry. Lloyd Neck, L. I.—A. Hollick.
Myrsinites (?) *Gaudini* Lesq. Tottenville, Staten Island.—A. Hollick.

EBENACEAE.

Diospyros apiculata Lesq. Glen Cove, L. I.—David White.
Diospyros primaeva Heer. Glen Cove, L. I.—David White.
Diospyros prodromus Heer. Glen Cove, L. I.—D. White.
Diospyros provecta Velenovsky. Tottenville, Staten Island.—A. Hollick.
Diospyros pseudoanceps Lesq. Glen Cove, L. I.—A. Hollick.

CAPRIFOLIACEAE.

Viburnum hollickii Berry. Lloyd Neck, L. I.—A. Hollick.
Viburnum integrifolium Newberry. Glen Cove, L. I.—A. Hollick.

OTHER DICOTYLEDONES

Dewalquea gronlandica Heer? Tottenville, Staten Island.—A. Hollick.
Dewalquea insignis Hosius and von der Marck. Kreischerville, Staten Island.—A. Hollick.
Phyllites poinsettioides Hollick. Kreischerville, Staten Island.—A. Hollick.
Premnophyllon trigonum Velenovsky. Glen Cove, L. I.—A. Hollick.

INCERTAE SEDIS.

Calycites alatus Hollick. Montouk Point, L. I.—A. Hollick.
Carpolithus evonymoides Hollick. Tottenville, Staten Island.—A. Hollick.

Carpolithus vaccinioides Hollick. Kreischerville, Staten Island.—A. Hollick.

Carpolithus sp. 5 undetermined species from Green Ridge and Kreisecherville, Staten Island.—A. Hollick.

Credneria macrophylla Heer. King's gravel pit, Roslyn, New York.—A. Hollick.

Rhizomorphs. In hard clay ironstones at Tottenville, Staten Island.—A. Hollick.

Tricalycites major Hollick. King's Gravel Pit, Roslyn, Glen Cove, L. I.—A. Hollick.

Tricalycites papyraceus Newberry. Lloyd Neck.—A. Hollick.

Williamsonia Riesii Hollick. Kreischerville, Staten Island.—A. Hollick.

INSECT GALLS.

Burnham and Latham (1914-24) list the following insect galls from their Flora of the Town of Southold, Long Island, and Gardiners Island. Doubtless many of them may be found further west along the coast in the vicinity of Cold Spring Harbor.

Acarus Serotinae Beutm.—Wild Cherry Pouch Gall.

Acraspis erinacei Walsh.—Oak Hedgehog Gall.

Amphibolips acuminata Ashm.—Very abundant on *Quercus ilicifolia* at Laurel, L. I.

Amphibolips confluentus Harr.—Oak Apple.

Andricus cornigerus O. S.—Horned Knot Oak Gall.

Andricus futilis O. S.—Oak Wart Gall on leaves of *Quercus alba.*

A. palustris O. S.—Succulent Oak Gall on leaves of *Quercus palustris.*

A. petiolicola Bass.—Oak Petiole Gall on leaves of *Quercus alba* and *Q. velutina.*

A. punctatus Bass.—Oak Knot Gall.

A.seminator Harr.—Oak Seed Gall.

Asphondylia globosus O. S.—On stems of *Helianthus divaricatus.*

Asteromyia carbonifera Felt.—On leaves of Euthamia tenuifolia.

Asteromyia rubra Felt.—On leaves of *Solidago bicolor.*

Aulax tumidus Bass.—Lettuce Tumor Gall.

Biorhiza forticornis Walsh.—Oak Fig Gall on twigs of *Quercus alba.*

Caryomyia tubicola O. S.—On leaves of *Hicoria glabra* at Cutchogue, L. I.

Cecidomyia Caryaecola O. S.—Hickory Seed Gall.

C. holotricha O. S.—Hickory Onion Gall.

C. niveipila O. S.—Oak Fold Gall.

Cecidomyia verrucicola O. S.—On leaves of *Tilia americana* at Southold, L. I.

C. Nyssaecola Beutm.—On leaves of *Nyssa sylvatica.*

C. (?) *ocellaris* Comstock— Maple Spot Gall on leaves of *Acer rubrum.*

C. sanguinolenta O. S.— Hickory Cone Gall.

C. Serotinae O. S.—Wild Cherry Bud Gall.

Cinsticornia pilulae Walsh.—Oak Pill Gall on leaves of *Quercus velutina.*

Cecidomya viticola O.S.—On leaves in *Vitis* at Mattituck.

Cynips Pisum Fitch—Oak Pea Gall.

Cystiphora canadensis Felt.—On leaves of *Nabalus.*

C. viburnifolia Felt.—On leaves of *Viburnum acerifolium* and *V. dentatum.*

Dasyneura Galii Felt.—On flower buds of *Galium.*

Dasyneura Yysmachiae Beutm.—On *Lysimachia quadrifolia* at Orient, L. I.

D. Salicifolia Felt.—On young willow leaves.

Diastrophus Cuscutaeformis O. S.—Blackberry Seed Gall.

D. nebulosus O. S.—Blackberry Knot Gall.

D. niger Bass.—On leaves of *Potentilla canadensis.*

Disholcaspis mamma Walsh.—On twigs of *Quercus velutina* at Greenport, L. I.

Diastrophus Potentillae Bass.—Cinquefoil Axil Gall; on stems of *Potentilla Canadensis.*

Dryophanta polita Bass.—Polished Oak Gall.

Erineum fagineum Pers.—Beechleaf Mite Gall.

Eriophyes abnormis Garman—A mite gall on leaves of *Tilia americana.*

Eriophyes Cephalanthi Cook.—Greenport on leaves of *Cephalanthus occidentalis.*

E. Nyssae Trotter.—On leaves of *Nyssa sylvatica.*

E. Querci Garman.—On leaves of *Quercus velutina.*

E. semen Walsh.—Orient on leaves of *Salix.*

Gnorimaschema gallaesilodaginis Riley—On stems of *Solidago serotina.*

Holcaspis globulus Fitch.—Oak Bullet Gall.

Hormaphis Hamamelidis Fitch.—Witch Hazel Cone Gall.

H. spinosus Shiner.—Spiny Witch Hazel Gall.

Hormomyia canadensis Felt.—Cutchogue on leaves of *Amelanchier oblongifolia.*

Hormomyia Crataegifolia Felt.—On leaves of *Crataegus.*

Itonida foliora Russ & Hock.—On margin of leaves of *Quercus velutina.*

Lasioptera clavula Beutm.—On twigs of *Cornus* at Cutchogue, Greenport and Southold, L. I.

Lasioptera farinosa Beutm.—On leaf veins of *Rubus.*

L. Lycopi Felt.—On stems of *Lycopus.*

L. nodulosa Beutm.—Orient on stems of *Rubus.*

L. virginica Felt.—On stems of *Triadenum virginicum.*

L. Vitis O. S.—Grapevine Tomato Gall.

Livia maculipennis Fitch.—On the inflorescence of *Juncus canadensis.*

Nematus pomum Walsh.—Willow *Apple* Gall.

Neolasioptera Erigerontis Felt.—On stems of *Leptilon candense.*

Neloasioptera ramuścula Beutm.— On stems of *Doellingeria umbellata* at Orient, L. I.

N. vitinea Felt.—On petioles of grape leaves.

Neuroterus batatus Fitch—Oak Potato Gall on twigs of *Quercus alba.*

N. majalis Bass.—On leaves of *Quercus alba.*

Obolodiplosis Robiniae Hald.—On leaves of Robinia *Pseudo-Acacia.*

Neuroterus noxosus Bass. — Leaves of *Quercus Prisus* at Greenport.

Oligotrophus salicifolius Felt.—On leaves of *Robinia pseudo-acacia.*

Pachypsylla Celtidis-gemma Riley.—Hackberry Nodule Gall.

P. Celtidis-mamma Riley.—Hackberry Nipple Gall.

Pemphigus Populicaulis Fitch.—Popular Stem Gall.

P. Rhois Fitch.—Summac Tomato Gall on leaves of *Rhus glabra.*

Phylloxera Caryaecaulis Fitch.—Hickory Louse Gall.
P. Caryae-globuli Walsh.
Phylloxera Caryaesemen Walsh.—Orient on the under surface of the leaves of *Hicoria glabra.*
P. vastatrix Planch.—Grape Phylloxera.
P. vitifolia Fitch.
Phytophaga rigidae O. S.—On leaves of *Salix discolor* at Southold, L. I.
Phyllocoptes quadripes Shim.—Leaves of *Acer rubrum* at Greenport.
Rhabdophaga Salicifolia Felt.—On leaves of Spirea latifolia.
Rhabdophaga strobiloides Walsh.—On the tips of branches of Salix humilis at Peconic, L. I.
Rhodites bicolor Harr.—Spiny Rose Gall.
R. dichlocerus Harr.—Long Rose Gall.
R. globosus Beutm.—Globular Rose Gall.
R. ignota O. S.—Mealy Rose Gall.
R. verna O. S.—Knotty Rose Gall.
Rhopalomyia anthophila O. S.—On leaves of *Solidago.*
R. capitata Felt.—On stems of *Solidago.*
Rhopalomyia hirtipes O. S.—On aerial stems of *Solidago juncea* at Cutchogue and Peconic, L. I.
R. lateriflora Felt.—On stems of *Aster ericoides.*
R. racemicola O. S.—On flowers of *Solidago rugosa.*
Sackenomyia viburnifolia Felt.—On leaves of *Viburnum dentatum.*
Rhopalomyia Solidaginis Loew.—Goldenrod Bunch Gall.
Solenozopheria Vaccinii Ashm.—Huskleberry Gall on stems of *Gaylussacia baccata.*
Trypeta polita Lw.— Goldenrod Gall.
Trypeta Solidaginis Fitch.—Goldenrod Ball Gall.

BOOK REVIEWS

In this section are reviews of new, or particularly important and interesting books in the fields of natural science. Books dealing with botany or kindred subjects should be sent to the Editor, the University of Notre Dame. *All other books for review* should be sent to Carroll Lane Fenton, at the Walker Museum, the University of Chicago, Ill. Publishers are requested to furnish prices with books.

IMMS, A. D., M. A., D.Sc. A general Textbook of Entomology including the anatomy, physiology, development and classification of insects. E. P. Dutton and Co., New York. 698 pp. Price, $12.00.

The literature on entomology, already voluminous, is steadily growing. There are books on all the orders of insects and inumerable monographs on genera and species. But there was room for a volume that should comprehend the three-fold aspects of the whole subject,—structural, functional and developmental, and taxonomic. The present work is an attempt to produce such a volume. The attempt has been successful, and the author is to be congratulated on having given us a book that leaves nothing to be desired. Ripe, constructive scholarship is the keynote of the work. We know of no book in English where so much that is new has been collected and presented in so scholarly a manner. Condensation becomes an important factor in a book of this kind. But we have nowhere noted that brevity has been attained at the cost of completeness.

The first 157 pages of the book are devoted to a general treatment of insect morphology, the next 50 pages deal with insect embryology, and the remainder of the book—some 470 pages—give a careful review of the orders of insects. A feature that will be especially appreciated by the research student is the series of classified bibliographies at the end of the sections. These include all the more important original works on entomology.

There is a good table of contents, an authors' index and a complete general index. While the book seems to be intended for the specialist in entomology, the teacher or the research worker, it will be found useful for the general reader and certainly indispensible in every college and university library. —F. W.

A GUIDE TO THE TREES, By Dr. Carlton C. Curtis, Professor of Botany, Columbia University.

The best thing we can think of saying of any book is that it perfectly fulfils the purpose for which it was intended and we can claim this of this little volume. Tried on a young city boy that literally did not know one tree from another he succeeded after two or three attempts to determine any of them in a few minutes. Better still it

created a wholesome interest which is the main thing in self-education, and all education is best self made. We think it ought to be as much a part of the equipment of every boy scout and scout master as an ax or knife. It may incite them to use these less on our trees, and the other more to the boy's and community's greater advantage.

The American Midland Naturalist

PUBLISHED BI-MONTHLY BY THE UNIVERSITY
OF NOTRE DAME, NOTRE DAME, INDIANA

Vol. IX. SEPTEMBER, 1925. No. 11.

THE GEOLOGY OF LONG ISLAND WITH ESPECIAL REFERENCE TO THE COLD SPRING HARBOR REGION AND ITS FLORA.

N. M. GRIER.

To the botanist Long Island* is of peculiar interest. It presents some unusually attractive features in the sea beach and sand dune flora of the southern coast, in the pine barren region vegetation of the central part of the island, in the natural prairie, (Hempstead Plain), in the lake vegetation of Lake Ronkonkema, in the deciduous forests of the great terminal moraines which run the length of the island on which are found a considerable variety of forest trees under special conditions; in the salt marshes, bogs and submerged gardens, all of the foregoing being easily accessible from the Biological Laboratory at Cold Spring Harbor. The value of the natural resources of Long Island is unusually great because of their proximity to a great consuming center, and detailed studies of its climate, soil, water supply, physiography and flora have therefore been made. On this account the relation of the vegetation to the physical conditions is more easily determinable, and the flora has been

---

* This account of the Geology of Long Island is based on the following publications: Fuller M. L. The Geology of Long Island, N. Y., U. S. Geol. Survey Prof. Paper 82, 1914; Veatch, A. C. and others, Underground Water Resources of Long Island, N. Y., U. S. Geol. Survey, Prof. Paper 44, 1906; Bowman, Isaiah, Forest Physiography, published by John Wiley and Sons; and the account of the Camp Mills quadrangle given on that topographic sheet by W. C. Alden.

** Accompanying map drawn by J. F. Mueller, Department of Zoology, University of Illinois.

made the basis of extensive contributions to botanical knowledge.

GEOGRAPHY AND GLACIAL TOPOGRAPHY*

Long Island belongs to the inner part of the Atlantic Coastal Plain. Its greatest length is 118 miles and its greatest width 23 miles. The south shore is double—the inner or primary shore line is the border of a broad *lagoon*,—Great South Bay and its extensions; the outer shore line consists of narrow sand *reefs* of remarkably regular outline enclosing shallow bays and salt marshes. Opportunity is given to observe this double shore line in the annual excursion of the Laboratory to the south shore, Great South Bay being about one hour's drive by automobile from the Laboratory. The north shore is without notable indentation, but the western half is deeply embayed by a dozen or more well developed *fiords* such as Cold Spring Harbor, with steep sides and noteworthy depth of water. Here the fiord is five miles long and hardly a mile wide opening into Long Island Sound, itself an inland sea.** The vegetation of these harbors is well typified by that at Cold Spring Harbor, which has been made the subject of extensive study by Transeau ('13) Johnson, York and Conard ('15), Conard ('24).

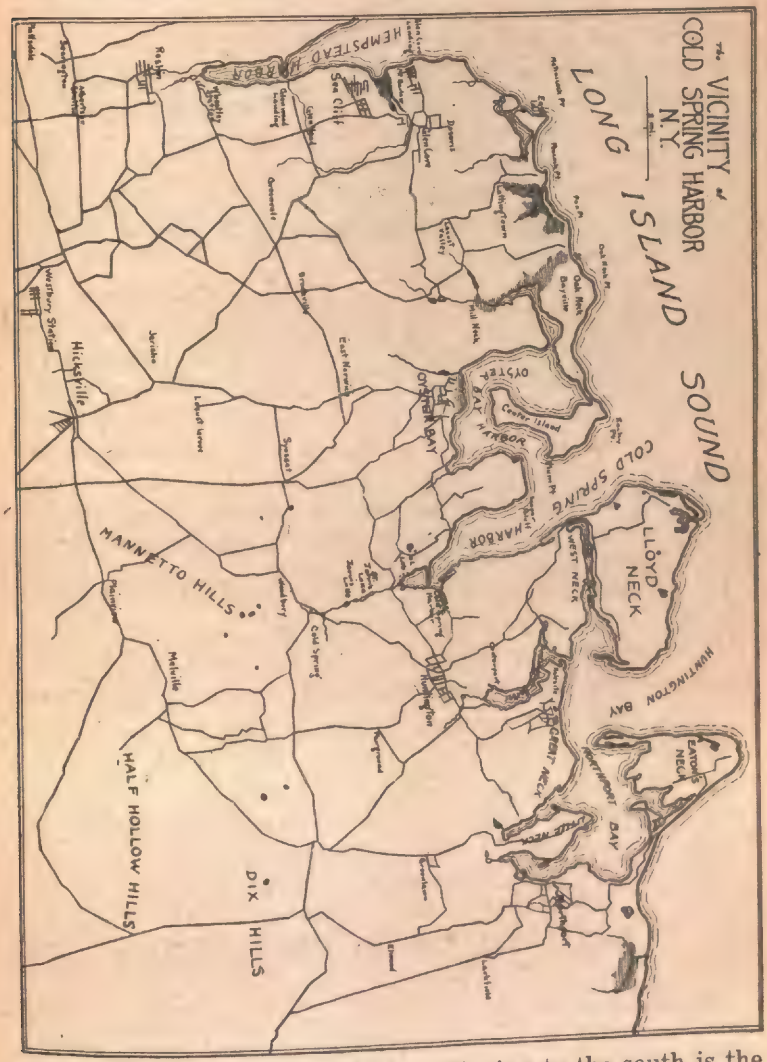
The profile section of Long Island north to south as one approaches the shore, indicates first a high plateau going inland. After a number of miles there arises abruptly to

---

* Topographic maps of the U. S. Geological Survey dealing with the immediate region of Cold Spring Harbor are those of the Oyster Bay and Northport quadrangles. Others dealing with Long Island are those of Staten Island, Brooklyn, Hempstead, Babylon, Fire Island, Sag Harbor, Easthampton and Montauk quadrangles on the southern shore; the Harlem, Setauket, Moriches, Riverhead, Shelter Island, Gardiner's island on the north shore. Geological Folios have been issued for the Staten Island, Harlem and Brooklyn quadrangles. The prices of the maps are $.10 each when obtained from the Survey, but they may also be obtained from Abercrombie and Fitch, 57 Reade St., N. Y., or at Rand, McNally Co., 42 E. 22nd St., at a slightly advanced price.

** The results of a Biological Survey of the waters of Long Island Sound by Dr. P. S. Galtsoff are in preparation and will be published by the U. S. Bureau of Fisheries.

a height of 100-150 ft. a high ridge composed of stratified materials. This is termed the Harbor Hill *moraine*, and it attains a height of 391 ft. above sea level, one and one-half



miles east of Cold Spring Harbor. Sloping to the south is the outwash formation. After a few miles south of irregularities, low ridges and mounds, another moraine is encountered—the

Ronkonkema—which is 410 ft. above the sea at High Hill, Huntington. It is considered to be the older of the two, since at places it is buried beneath the first. These two conspicuous morainal ridges form the backbone of the areas previously indicated, and each is a direct continuation of moraines of Wisconsin age which are traceable from the Rocky Mountains to New Jersey to Long Island, Nantucket and Cape Cod. East of Huntington, the moraines diverge more and more and enclose broad, sub level tracts. The coastal region, however, is comparatively level, with an elevation above sea level ranging from less than 50 ft. over the greater part of Long Island.

The glaciers invaded Long Island more than twice, for certain deposits of clay and gravel and sand show that there were advances of the ice even before the Ronkonkema moraine was formed. Most of the material composing the bluffs along the north shore and inlets is thought to have been laid down by this earlier ice sheet.* The eastern terminus of each moraine gives character to that end of Long Island and encloses a large body of water known as Peconic Bay. The Ronkonkema moraine is remarkable for the large body of water it encloses, Lake Ronkonkema, visited yearly by the botanical classes at the Laboratory. This is in a former glacial *kettle hole*, and is by far the largest lake on Long Island, attaining a depth of 80 ft., and extending to about 25 ft. below sea level. Both moraines bear the usual marks of terminal accumulations formed by the *continental ice sheet*. Their surfaces are deeply pitted by large and small kettle holes and depressions. Upon the floors of some of the enclosed depressions lakelets or swamps occur, and all others are distinctly moist, but by far the larger number are without standing water. Large portions of both moraines are composed of till of rather typical composition, but there are extensive localities where

* Dr. Ernest Antevs in a letter to the writer dated March 5, 1925, reports the finding of varied clay (the summer and winter deposits of glacial waters) at Glen Head, L. I., a few miles east of Great Neck, at a brick yard one-half mile east of the station. He adds that varves, (each of which represents one year of the glacial retreat), may be expected here and there on the northern coast as exposed.

sand may compose all or nearly all of it. The sandy phases are developed chiefly at the eastern end, the clayey phases at the western end of the island. Boulders, large and small are scattered freely upon the surface and throughout the mass of both moraines. They are of variable composition—gneiss, schists, sandstones and quartzites predominating.

The long, gently sloping *outwash plains* extending southward from the moraines have been mentioned. Their northern margins are in many places pitted by kettle holes. Examples of these kettle plains are found west of Cold Spring Harbor station at Syosset and southwest of Huntington at the fair grounds. Where kettle holes have permanently obtained a water supply they have frequently influenced the settlement of the island. Two papers by Conard ('13-'23) deal with the revegetation of an area near Syosset which had become denuded artificially, and his observations yield clues as to the method of the first occupation of these outwash plains by the post glacial flora of Long Island.

The porous nature of the outwash material greatly reduces the run off of precipitation and instead of a normal run off of about 30%, such is only about 20% of the normal. The reduced run off has retarded the dissection of the frontal plains and the small elevation has favored the same result. There extend mile after mile of almost flat plains of alluvium in striking contrast to the ruggedness and picturesqueness of the terminal moraine. Plenty of old channels mark the beds of former streams, but few streams flow in them. The present drainage consists chiefly of small, wet weather streams extremely diminutive as compared with the ancestral streams whose channels they occupy. Veatch ('06) has shown that the effect of dams on the brooks of Long Island is to very materially decrease the stream flow at the points where dams are erected, and keeping in mind the foregoing, it may be deduced that a large amount of water escapes through the porous sides of the pond. Illustrative of the effect of this condition on vegetation of Long Island is Harper's account of a Long Island cedar swamp ('07). This swamp is located at Merrick, near the south shore of the island.

Excavations on the plain expose waterworn gravel and

sand and the evidence is that it originally was a natural *prairie* in the midst of a generally wooded region. The south plain is somewhat more extensive than the north plain, (which is between the two moraines), and ranges in width from less than a mile to more than 10 miles. A large tract of the surface of the south plain in the vicinity of Mineola, Hempstead and Camp Mills has always been open prairie, but elsewhere both the north and south plains were once covered with scrub oaks, scattered pines and underbrush and the terms "brushy plain" and "pine plain" which were in early days used to distinguish parts of them from the Hempstead plains, are still widely applicable. In North Hempstead the south plain stands 120 ft. above sea level, but north of Hicksville it rises to 200 ft. It is not much cut by sharp ravines or valleys, but is traversed from north to south by a series of channels 10-20 ft. deep, in the bottom of which springs issue and feed small streams that flow through the southern third of the plain, finally discharging into the marsh bordered channels at the south shore. Harper ('12, '18) has made a valuable study of the vegetation of this natural prairie, relating it to the geological conditions indicated. The prairie is within 5 miles of Cold Spring Harbor. Hicks (1892) first comprehensively listed the plants from this region.

The valleys of Long Island are generally free from conspicuous branching as would be expected if produced by the ordinary process of stream erosion. On the borders of each main valley are many smaller later valleys sloping toward the harbors, and more or less filled with late *drift*. Some of the original valleys of Long Island are buried, and were formed by glacial waters as well as by existing streams. The valleys in the Manhasset formation (Pleistocene) are everywhere conspicuous, having been cut from an elevation of 200 ft. Most have become modified from the action of the ice or the deposition of glacial debris. In many the modifications are confined to the deposition of a superficial mantle of drift. There may be low morainal accumulations on the valley sides such as that at Cold Spring Harbor. The slope of the bottoms of the valleys is usually gentle, 10-15 feet per mile, and they flatten in the lower mile or two per-

mitting these parts to be occupied by the estuaries of the sea, and causing a slackening of the drainage. Such is the condition at Cold Spring Harbor. (Johnson and York, Conard, *loc. cit.*)

"Cold Spring Harbor,* which extends back in the Country for 3 miles from the upper end of the harbor, is a sunken river valley. In the valley runs the stream of Cold Spring Creek, which expands at three different levels into broad, deep and shallow ponds connected by waterfalls and shaded by dense foliage. Cold Spring Creek, flowing laden with silt into the upper end of the harbor has aided the sea in forming the *sandspit* which nearly cuts off an inner basin having an area of 110 acres at high water and 45 acres at low water, the mean range of the tide being 7.75 ft. and the maximum depth being 7 ft. over an area 100 ft. in diameter. The inner harbor is silting up, and its water is decidedly brackish at high tide varying from 1.006 to 1.016 at the surface and from 1.006 to 1.018 at the bottom.

The passage from the inner basin to the harbor is only 200-300 ft. wide at low tide, and through this gut the water flows at times with great rapidity. The steep sides of the harbor are piles of glacial drift full of clay, siliceous sand and gravel and boulders of varying size. This determines the prevailing character of the shore line, sandy or gravelly beaches with boulders extending into deep water and most abundant at the base of the worn off bluffs. Mud flats are common, but for the most part are underlaid with sands at a depth of 1-3 ft. A mud flat extends from parts of the sandspit at the level of mean low tide. No rock occurs in place, but on many headlands the accumulated boulders form an extensive rock work. At intervals the shore line is diversified by salt meadows, partly enclosed salt ponds and shallow harbors and bays.

Opening into Cold Spring Harbor at about the middle of its western side is Oyster Bay, a tortuous body of water running back some 6-7 miles and having a breadth varying from 1½ miles to ½ mile. Oyster Bay also receives at its

* Following the account of Davenport, C. B., and Johnson, D. S. The Flora about Cold Spring Harbor ('98).

upper end a fresh water stream, Mill Creek, which is of considerable volume, while both harbors receive at intervals along their coast line smaller streams. In the outer harbor above the entrance to Oyster Bay the water is uniformly 15-18 feet deep at low tide. Immediately below Oyster Bay entrance is a bar with only 6-10 ft. of water at low tide. At the eastern end of this bar is a channel 72 ft. deep. Outside of the bar the water deepens steadily toward the middle of the sound."

The flora of the outer coast of the north side of the island, of the quiet mud bottomed pools a hundred yards back from the outer beach which are flooded at high water by salt creeks, of the boulders scattered along the shores of the harbor, of the quiet brackish areas near its inner end, of the lakes at the upper end of the valley, of the springs and pools on the edges of these lakes and the dense woods surrounding them forms the basis of this list, to which have been added the plants encountered on the excursions of the botanical classes.

Observations indicate that about four-fifths of the ordinary shallow valleys lying south of the outer moraine have steeper banks on the west than on the east side. A study by the writer ('23) indicates that the cumulative effects of wind and vegetation upon wind borne materials may explain this in part at least. Exceptions appear, however, in the deepest valleys. Here the configuration depends on the curvature of the streams. The erosion and cutting continue unto the present day on the south shore where the water table comes to the surface and supplies short streams with water. The side slopes of the valleys are in large part steep and wooded and are not now undergoing rapid change but storm waters cut ravines in them, and springs here and there form gullies and cause loose sand to flow out as quick sand.

The south coast originally consisted of broad, lobelike projections of sand and gravel since extended by the formation of marsh deposits. Some believe these lobes were formed by the deposition of materials carried out by the melting ice, and that the southern two-thirds of the island is thought to be made up of confluvial deltas from glacial

streams; others that the sands and gravels of the south side represent the underlying Tertiary formations.

Taylor, ('15), remarks that "the glaciated portions of our range, besides being the home of so many native plants not found elsewhere is typified by the large percentage of hardwood trees, the relative scarcity, numerically of coniferous trees and above all by the great number of species introduced. Perhaps three fourths of all adventive and naturalized species find their greatest development in this area. The glaciated portion (Long Island) contains many swamps, ponds and bogs and it is the latter that are the chief interest to the botanist. These undrained areas maintain a flora quite characteristic. It has been shown that that section . . . which was neither glaciated nor on the coastal plain does not contain these plants, characteristic of the glacial bogs of the north and also found in the typical cranberry bogs of the coastal plain." Swamps, ponds and bogs are readily accessible to the botanist in the immediate vicinity of the Laboratory at Cold Spring Harbor, and the region of Lake Ronkonkema, while the classes make excursions to the nearby bog at Woodbury. A popular article in this connection is by Vail ('95) dealing with the June flora of a Long Island swamp.

Taylor ('15) also gives a list of ferns, fern allies and seed plants found only north or south of the moraine. Additions to the Flora of Long Island north of the moraine but not necessarily limited to that region are found in recent papers by the writer, ('24-'25). Little if any work has been done in this connection upon cryptogamic groups. Harper, (1917a,b.) has described the conditions of vegetation in the glaciated and unglaciated portions of Kings and Queens Counties in the western part of Long Island, bringing out interesting differences.

Taylor, ('15) additionally points out "Long Island is geographically unique in that the terminal moraine abuts directly on the coastal plain for nearly the whole length of the island. Whether as previously indicated the region south of the moraine is mostly overlaid with overwash material from the glacier or whether the sands or gravels of the south sides are the underlying Tertiary formations, may be

a matter of doubt. It would make an interesting future study to determine the effect if any of the distribution of these different sands and gravels on the distribution of the plants on the island."

Associated with Tertiary soils and the coastal plain are the Pine Barrens of Long Island which have been described in part by Britton ('80), Harper ('08) and for Staten Island by Burnham ('13).

RECENT EPOCH

During post glacial times transportation has taken place on a large scale; the waves cutting into the bluffs at Montauk Point and at some places farther west, have sorted out a vast amount of sand which has been transported southwestward in the direction of the prevailing winds, and has been built into *bars*, crossing the narrower inlets and into notable *barrier beaches* such as Fire Island and Rockaway beaches, and across wider bays. Storm waves sometimes cut channels through these barriers, and some of the channels are kept open by the tidal flow, the outflow from enclosed bays. The surfaces of these beaches are in many places diversified by hillocks of wind blown sand or *dunes* 10-30 ft. in height. The growth of vegetation in the shallow waters behind the barrier beaches has produced a great marsh which is intersected by a bewildering maze of channels and small bars. These deltas, beaches, bars, dunes, and the sandspits, marshes and connecting beaches to be mentioned constitute the recent series of deposits and as will be seen are in the process of formation today. The vegetation of the region of Montauk has been extensively studied by Taylor ('23) and in less detail by Clute, ('97-'99).

When the ice retreated there were many disconnected islets adjoining the mainland. In most places the intervening waters were shallow. The waves and shore currents rapidly extended hooks and spits completing Long Island as it now appears. Marshes and beaches served as connecting agencies in the cases of Oak Neck and Center Island, while Lloyd and Eaton Necks are connected by beaches alone. Such beaches are thought to have joined with Long Island what must have been 15 distinct islands. Studies

of interest indicating the nature of the process, i. e., marsh formation during recent years are those of Johnson, York, and Conard, *loc. cit.* Harshberger ('07-'16) has also made marked contributions to our knowledge of the vegetation of these salt marshes.

The bluffs of the open northern coast are mostly free from vegetable growth. The remainder are artificially covered with grasses, trees and other vegetation as at Cooper's Bluff. The whole line of the coast may be changed by a single storm which may eat into the bluffs, or throw up in front barriers of sand gravel according to the direction of the wind, angle of impact of the waves and nature of the currents set up. As the larger stones that slide down the bluff are moved but little if at all by the waves, they accumulate in some places and there protect the shore. The barriers stay until removed by storms and currents in other directions. Some last for years on account of grasses and trees taking possession of them, but sooner or later cutting begins again. The cliffs are best preserved where coherent materials exist in them. Good exposures of their component structures are found at Eaton and Lloyd necks. In the regions where they are destroyed there ensue lesser bars, beaches and spits connecting smaller islets with the mainland or projecting into harbors, (such as the sand spit at Cold Spring Harbor), the bays or the sound. Generally, the current flowing out of the inlet is strong enough to keep a narrow channel open, but the waves form a hook at the tip of the spit. The prevailing direction of the wind on the north shore is westerly, but the direction changes frequently, when under certain conditions spits may be extended from both sides of a point or inlet. Such processes have largely made the shore of Long Island more regular. A detailed account of the formation of the sandspit at Cold Spring Harbor and its animal ecology has been given by Davenport, ('03), while the plant ecology has been studied by Johnson, York and Conard (*loc. cit.*)

Long Island thus appears to have been the result of the opposed agencies of deposition and erosion. It is comparatively small now, for since Cretaceous times erosion has predominated over deposition. It is estimated that the amount

to be removed before the island is reduced to sea level is less than that removed in the past. The present form of the island appears to be due to constructive rather than destructive agencies. Since the disappearance of the ice sheet there has been some subsidence of the island—about 25 ft. Some think, however, this subsidence may indicate only the washing through of the lower beaches, or even local submergence. The studies of Johnson, York, and Conard, ('15) and Conard ('24) afford a quantitative basis for the further study on Long Island of this question from the botanical side.

TOPOGRAPHIC FEATURES RELATED TO STRUCTURE AND GEOLOGICAL HISTORY*

The basal deposits of Long Island consist chiefly of precambrian gneiss with intrusions of granite, dolomite and gneiss, the latter appearing as ledges on the banks of the East River.** Upon a base-levelled and down warped rock floor, Cretaceous and Tertiary materials were laid down, the line between the deposits of the coastal plain and the metamorphic rocks crossing the extreme west end near Long Island city. The Cretaceous deposits correspond to beds of similar age in New Jersey and southwards. They have not been seen however, in the western half of the island nor have positive equivalents of the Tertiary deposits of the mainland been noted. Only a part of the deposits are true coastal plain deposits, the greater portion of the underlying surface being material of Pleistocene age representing the morainal and outwash accumulations associated with continental glaciers. The Cretaceous is highly developed and possibly comes to the surface at High Hill at Huntington.

---

* The account given by Hollick ('93) is followed here.

** Among the minerals found on the beach of the sandspit at Cold Spring Harbor are red sandstones and shales evidently from the Connecticut Valley lowland, arkose sandstone, quartzite, grey quartzite, quartz schist (slate schist), granite, mica schist, granite gneiss, quartz (rosy, smoky, yellow), conglomerate. Cretaceous clays at Cold Spring Harbor also yield pyrite, limonite and lime concretions.

For the collection of these minerals I am indebted to Miss Betty Watt, University of Pittsburgh, for their identification to Professor J. W. Goldthwaite of Dartmouth College.

Two outcrops of Cretaceous materials occur on the west side of Cold Spring Harbor, one one-half mile south of Cooper's Bluff, the other opposite the village, one-half mile northwest of the sandbar. Above are the Wisconsin stage deposits consisting of till, stratified gravel, and also white sand, yellow, white and salmon colored clays. On the east side of the harbor are abandoned clay pits, south of Lloyd Beach which connects Lloyd and West Necks. Here occur diatomaceous deposits, and Cretaceous plant fossils, (see list), indicating a past land connection with New England. Our knowledge of the fossil flora of Long Island is mostly due to the researches of Hollick ('93-'12) with Newberry ('86) Ries, ('84) and Jeffrey ('06-'08) adding important contributions.

Following the laying down of Cretaceous and Tertiary materials, (clays, sands, gravels and marls), along the eastern borders of the north American continent an era of elevation began, which raised them hundreds of feet above their present level, forming a wide coastal plain which extended into what is now a part of the bed of the Atlantic Ocean, probably at the 100 fathom contour. It is thought to have been bounded on the land side by the crystalline and Triassic rocks of Connecticut, southern New York and Pennsylvania. There is reason to believe that its limits were approximately that of the coast line today. This area will be seen to include the whole of Staten Island, Long Island, Block Island, Martha's Vineyard and Nantucket besides a large portion of the submerged coast, eastward and southward.

The ensuing erosion was first normal, and resulted in the formation of an inner lowland where Long Island Sound occurs. The erosion of this inner lowland was continued to the point where a well developed *cuesta* was formed and it is to the further accumulation of glacial materials upon the summit of the cuesta that Long Island owes its present marked contrast between rugged moraine and abrupt high shores on the one hand and smooth southern plain, with low reedy, flat southern shores on the other. The scouring action of the ice sheet further deepened the inner lowland and with the final disappearance of the ice sheet from the

region a slight sinking of the land brought out even more strongly the features owing to depression. It seems probable that at some time during the oscillations of level, that the sea having eaten away the coastal plain, finally reached the barrier of the terminal moraine. The moraine gave away in places, channels were formed and detached portions remained to form islands recognized today as Block Island, Martha's Vineyard, Nantucket and the many lesser islands streaming from the end of Long Island toward Cape Cod, while the eroded portions are represented by the great submerged ridges known as the Nantucket or other shoals.

SOILS AND VEGETATION

"Soil maps of Long Island show four broadly defined types of soils: (1) stony loams and gravels which occupy the terminal moraine and the narrow plateau between the northernmost moraine and the north shore as in the vicinity of Cold Spring Harbor; (2) coarse sandy loams which constitute the greater portion of the outwash plains; (3) fine sandy loams which form the outer fringe of the outwash plains and those portions of it adjacent to the old drainage ways; (4) clay loams that form a transition type between the upland and the salt marsh and the beach sands. While the clay loams have greater natural fertility than the sandy loams they are often found on lands too rough for cultivation and the great market gardens are found on the outwash plains principally where many of the conditions are ideal.

Of the soil types apt to be encountered in the area covered by the accompanying list of plants there is first the Alton stony loam which is found in the immediate vicinity of Cold Spring Harbor. "A large portion of the Alton stony loam was formerly predominantly forested with chestnut and a characteristic undergrowth of mountain laurel, the moraine particularly, bearing scarlet and red oak, some white oak, hickory, chestnut, and in a few localties scattered pitch pines. Dogwood forms a notable undergrowth with masses of fern

* For a detailed discussion of the soils of Long Island see Soil Survey of the Long Island Area, N. Y. Bonsteel, J. A. and party, U. S. Dept. of Agriculture. Bureau of Soils, 1903.

and considerable greenbrier among minor plants. Unoccupied fields grow up to cedar. The locust thrives on this soil, and is cared for to form a supply of fencing material. In the more western area of the island market garden crops are produced from this soil, and it is well adapted to the later truck crops." The village of Bayville is built upon the Alton stony loam.

The Galveston sand composes the sandspit at Cold Spring Harbor, is found also at Cooper's Bluff, and forms the sand dunes of the ocean shore,, where it becomes covered with wiry grass, cedars, and oaks. It has no value as an agricultural soil. With the Galveston sandy loam it makes up the beaches of the south side of the island, and connects most of Center Island with the mainland. The Galveston clay forms the banks of Cold Spring Creek near the Laboratory. It is constantly saturated with tide water.

At the top of the hill on the east side of the inner harbor one encounters the Miami stony loam. It was originally strewn with large sized erratic glacial boulders, and is a typical glacial soil. Its texture and structure place it in the group of grass and grain producing soils. It is the most drought resisting type found on Long Island and produces good yields of later truck crops, but the majority of the crops are produced by the fertilizer rather than the inherent fertility of the soil. This soil also occurs at Lloyd and West Necks, and covers most of Center Island.

East of Cold Spring Station and in the vicinity of the fairgrounds at Huntington is the Hempstead loam. It is the chief soil of the Hempstead Plain. It is however underlaid at a depth of about 2 ft. by a bed of rounded quartz gravel—"hard pan"—which is a determining factor in the vegetation of the plain. The Hempstead gravelley loam occurs around the margins of the Hempstead loam, and in the narrow dry stream beds of the plain.

The Norfolk sand occurs in the pine and scrub oak country, north of Lake Ronkonkema and the country just north of Babylon, Bayshore and Islip. It is the typical pine barrens soil, and is too much subject to drought to be of value for cultivation. The distribution of stunted species of oaks on certain sections of the moraine corresponds almost pre-

cisely with that of the Norfolk sand. South of High Hill at Huntington occurs the Norfolk gravel. It is referred to earliest Pleistocene deposition. Agriculturally, it is useless. Southeast of Cold Spring Station is a small patch of the Sassafras gravelly loam. It is well drained, and is intensively cultivated for garden crops. This type also occurs at St. James, Long Island.

CLIMATE*

This is maritime in type. The tempering influence of the Atlantic Ocean is modified to a considerable extent by the prevailing westerly winds from the continental interior, giving the region relatively mild winters for the latitude and not excessively warm summers, long growing season and abundance of precipitation well distributed throughout the year, and rather high relative humidity. On Long Island the dryest month is April with a total of 7.3% of the total annual precipitation while the wettest is August with 10.5%. The winter rainfall is generally greater than that of spring or autumn, and only 3% less than of summer. The average length of the growing season between the last killing frost of spring and the frost of the fall is something over 200 days for Long Island. For the benefit of botanists desiring the use of the facilities of the Laboratory throughout the year the following records compiled from those of the U. S. Weather Bureau are cited.

The means of the records of the monthly, annual and average amount of precipitation in inches of the two nearest weather stations to Cold Spring Harbor are:

STATIONS	Elev.	No. yrs.	Jan.	Feb.	Mar.
Oyster Bay	50 ft.	12	3.88	2.39	3.72
	Apr.	May	June	July	Aug.
	4.09	3.48	3.61	4.26	6.68
	Sept.	Oct	Nov.	Dec.	Annual
	4.3	3.68	2.53	3.47	46.09

* Compiled from reprint of section 104. Eastern New York Summary of Climatological data for the United States by sections, U. S. Dept. of Agriculture, Weather Bureau.

	Elev.	No. yrs.	Jan.	Feb.	Mar.
Roslyn	220 ft.	9	4.17	3.62	4.31
	Apr.	May	June	July	Aug.
	3.78	3.70	3.55	3.73	4.59
	Sept.	Oct	Nov.	Dec.	Annual
	3.78	3.43	2.82	4.57	46.05
	Elev.	No. yrs.	Jan.	Feb.	Mar.
Setauket	40 ft.	35	4.	3.98	4.29
	Apr.	May	June	July	Aug.
	3.74	3.44	2.73	4.17	4.31
	Sept.	Oct	Nov.	Dec.	Annual
	3.50	4.12	3.66	4.03	45.97

The principal temperature records are from Setauket where the station is located on a neck of land that projects into the estuaries of Long Island Sound, ground level, and nearly surrounded by water.

TEMPERATURES AT SETAUKET

	Jan.	Feb.	Mar.	Apr.	May	June	July
Mean (35 yrs.)	30.8	29.5	37.1	47.3	57.9	66.2	72
Highest temp. (31 yrs.)	66	64.	75	87	91	93	98
Lowest temp. (31 yrs.)	–3	–6	7	21	34	40	50

	Aug.	Sept.	Oct.	Nov.	Dec.	Annual
Mean (35 yrs.)	70.6	64.8	55	44.3	34.6	50.8
Highest temp. (31 yrs.)	95	93	86	71	63	98
Lowest temp. (31 yrs.)	50	37	31	16	–7	–7

For Setauket, in 31 years, the earliest date of the last killing frost in the spring is given as March 27 with the latest May 17. The average date, however, is found between the second and third week of April. In the fall, the date of the earliest killing frost is Oct. 22nd, the latest November 29, the average occurring in the first and second weeks of November. For this same point the greatest growing season recorded has been 247 days, the minimum 158 days, with an average of 211 days.

THE FLORA OF COLD SPRING HARBOR AND BOTANICAL RESEARCH

Opportunities for the systematic botanist are indicated at least in the paucity of records for certain plant groups in the accompanying list, especially the cryptogams. The records to date include the following main divisions of the plant kingdom, exclusive of the Bacteria, and to this list may be added the records of Jelliffe ('99-'04) Burnham and Latham ('14-'24) Fish ('25), Bigelow ('22).

GROUP	GENERA	SPECIES
Schizophyceae	20	47
Myxomycetes	26	57
Flagellatae	7	9
Dinoflagellatae	6	14
Silicoflagellatae	2	2
Diatoms	44	75
Conjugatae	18	59
Chlorophyceae	32	51
Charophyta	2	5
Phaeophyceae	22	33
Rhodophyceae	37	54
Phycomycetes	9	9
Ascomycetes	37	53
Basidiomycetes	82	185
Fungi Imperfecti	16	20
Lichenes	15	32
Hepaticae	22	38
Musci	43	63
Filicales	21	32
Equisetales	1	1
Lycopodiales	2	5
Isoetales	1	1
Gymnospermae	9	13
Monocotyledonae	106	234
Dictoyledonae	412	773
Totals	991	1,865

Protozoologists have remarked upon the unusual richness of the Flagellate flora of the Cold Spring region, but this has received little attention so far. The American forms should be more comprehensively studied, following the lead of Walton ('15). Additional records for the Dinoflagellates,

Silecoflagellates and Diatoms may be expected in the forthcoming report of the Biological Survey of Long Island Sound conducted by Dr.P.D.Galtsoff under the direction of the U. S. Bureau of Fisheries. Material in the possession of Professor Transeau will undoubtedly yield new records for the Conjugatae and Chlorophyceae. Many exotic species of ferns and seed plants are represented in the gardens of estates in the vicinity of Cold Spring Harbor. The estates have generally been available to members of the Laboratory, and their flora will be the subject of a later list by the writer. Botanists will be able to collect abundant material for class room use in the vicinity of the Laboratory, while the range of the flora may prove suggestive to the plant anatomist. Of especial interest to the latter are the fossil plants of long Island, the structure of some species of which have been studied by Hollick and Jeffrey ('09) but many have not received such attention.

The account given of the relation of the geology of Long Island to the flora, so far as it has been studied, may be of interest to the plant ecologist. As suggested by Conard ('24) it is hoped that observers may be found to study the succession of the vegetation in subsequent years in the salt marsh and sandspit. Investigations of the salinity of the water in the various creeks and rivers flowing into Cold Spring Harbor, and the rate of evaporation at different levels above and below high water marks await plant physiologists, to whom the flora of the salt marshes, especially those plants which are exposed to both fresh and salt water are of peculiar interest. Opportunities for the plant geneticist are at present mostly limited to collaboration with members of the staff of the Carnegie Institution.

The adjacent library of the Department of Genetics, Carnegie Institution of Washington, the easy accessibility of the New York Botanical Garden, the Brooklyn Botanic Garden, the American Museum of Natural History in New York City, and the Boyce Thompson Institute for Plant Research at Yonkers, N. Y., in addition to the above make the Biological Laboratory at Cold Spring Harbor, N. Y., a convenient center for botanical research the year around within of course the limits of the type of investigation to be pro-

jected. The increased facilities now being planned by the Board of Directors will make it even more so.

PARTIAL BIBLIOGRAPHY OF THE FLORA OF LONG ISLAND AND VICINITY

WITH REFERENCE WORKS OF USE IN CONNECTION.

1870—Allen, T. F. The Oenothera of Montauk Point, Long Island. Bull. Torrey Club. 1:2,3.

1904—Adams, C. C. The Post-glacial dispersal of the North American Biota. Rept. Int. Geog. Cong. 8:623-637.

1907—Barnhart, J. H. A New Utricularia from Long Island. Bull. Torrey Bot. Club. 34 p. 579-82.

1893—Barstow, Josiah Whitney. The trees of Flushing. Flushing Evening Journal, 8 Je 1893. (Also in pamphlet form, 4 pages.)

1911—Bartlett, H. H. Botanical Evidence of Coastal Subsidence. Science II. 33:29-31.

1897—Bennett, H. C., and Jelliffe, S. E. Local Cryptogamic Notes (Diatoms From Van Cortland Lake.) Bull. Torrey Club 24:412.

1880—Bicknell, E. D. Some of the Rarer Plants of our Northern Suburbs. Bull. Torrey Club. VII. 51-54.

1904—Bicknell, E. P. Three New Violets From Long Island. Torreya, Vol. 4:129-132.

1908—Bicknell, E. P. Ferns and flowering plants of Nantucket. Bull. Torrey Bot. Club. 35:49-62.

1908—Bicknell, E. P. A White Cedar Swamp on Western Long Island. Torreya 8:27-28.

1914—Bigelow, H. B. Oceanography and Plankton of Massachusetts Bay and adjacent water, Nov. 1912—May 1913. Bull Mus. Comp. Zoology at Harvard College. LVIII:385-419.

1922—Bigelow, H. B. Exploration of the Coastal Waters off the N. E. United States in 1916 by the U. S. Fisheries Schooner Grampus. Bull Mus. Comp. Zoology at Harvard College, Vol. LXV. No. 5.

1886—Bisky, J. A. Ph. G. Catalogue of Phaenogamous and Vascular Cryptogamous Plants of Queens County, L. I., showing distribution through various townships. Flushing, L. I. Manuscript and Herbarium in Flushing High School.

1887—Bisky, Julius A. Notes from Queens County, Long Island. Bull. Torrey Club 14:13, 14.

1916—Boyer, C. S. "The Diatomaceae of Philadelphia and Vicinity" J. B. Lippincott and Co., Philadelphia, Pa.

1890—Britton, E. G. Preliminary List of the Mosses of Staten Island. Proc. Nat. Science Assoc. of Staten Island. Special No. 11. 1890.

1898—Britton, E. G. List of Mosses Collected at Arlington, Staten Island, Sept. 27, 1896. Proceedings Natural Science Assoc. of Staten Island 6:54.

1902—Britton, E. G. Notes on a Long Island Moss. Bryologist Vol. 5. 66:67.

1877-79—Britton, N. L. Staten Island Plants. Bull. Torrey Bot. Club 6:177-78. 1877:259-50. 1878:323. 1879.

1880—Britton, N. L. On the Northward Extension at the New Jersey Pine Barren Flora on Long and Staten Islands. Bull. Torrey Bot. Club 7:81-83.

1881-84—Britton, N. L. On the Existence of a Peculiar Flora on the Kittatiny Mountains of Northwestern New Jersey. Bull. Torrey Bot. Club 11:126-28; 1884:187. 1887.

1884—Britton, Nathaniel Lord. List of algae (collected near Glen Cove) Ann. Rep. State Board Health, N. Y. 4:379, 380.

1889—Britton, N. L. Catalogue of Plants found in New Jesrey. Report of State Geologist 2:25-642.

1890—Britton, N. L. Forms of Staten Island Plants. Proc. Nat. Science Assoc. of Staten Island. 1890.

1904—Britton, N. L. An Undescribed Species of Alnus (A. noveboracensis) Torreya 4:124. 1904.

1905—Britton, N. L. W. A. Murrill and J. H. Barnhart, Editors. "North American Flora." N. Y. Botanical Garden, Vol. 1-34 published and in completion, consisting of monographs on the North American Flora.

1913—Britton, N. L., and Brown, A. Illustrated Flora of the Northern states and Canada. Charles Scribner's Sons, N. Y. Vol. I-III.

1878-1881—Brown, Addison. List of Plants Introduced into the Vicinity of New York with Ballast and on Made Land. Bull. Torrey Bot. Club. 6:255-258; 273 (1878) 6:353-60 (1879); 7:122-26 (1880) 8;141-42 (1881).

1917—Burlingham, G. A. Preliminary Report on the Russulae of Long Island. Mem. Torrey Bot. Club 16-17.

1913—Burnham, S. H. The Flora of the Sand Barrens of Southern Staten Island. Torreya 13:249-55. A correction by C. A. Hollick in Torreya 13:274-275: 1913.

1914-15—Burnham, S. H.; Latham, R. A. The Flora of the Town of Southold, Long Island and Gardiner's Island. Tor- the Town of Southold, Long Island and Gardiner's Island. Torreya 14:201-225; 229-254.

1917—Burnham, Stewart Henry; Latham, Roy A. The Flora of the Town of Southold, Long Island and Gardiner's Island. First Supplementary List. Torreya 17:111-122.

1917—Burnham, Stewart Henry; Latham, Roy A. Corrections of the Flora of the Town of Southold, etc. Torreya 17:164.

1921—Burnham, Stewart Henry; Latham, Roy A. The Flora of the town of Southold, Long Island and Gardiner's Island. Second supplementary list. Torreya 21:1-11; 28-33.

1923—Burnham, Stewart Henry; Latham, Roy A. The Flora of the Town of Southold, Long Island and Gardiner's Island. Third supplementary list. Torreya 23:3-9.

1924—Burnham, S. H.; Latham, R. A. The Flora of the Town of Southold Long Island and Gardiner's Island. 4th supplementary list. Torreya 24:22-32.

1849—Carey, John. Notes on Some Chenopodiaceae Growing Spontaneously about the City of New York. Amer. Journ. Science. II, 7:167-71.

1914—Chase, Agnes. Panicum wrightianum on Long Island. Rhodora 16:167.

1897—Cleve, P. T. A Treatise on the Phytoplankton of the Atlantic and its tributaries, and on the periodical Changes of the Plankton of the Skagerak. Upsala.

1905—Clinton, E. D. The Ustilaginae of Smuts of Connecticut. Bull. No. 5 State of Connecticut Geological and Natural History Survey.

1897—Clute, Willard Nelson. Some sand-barren plants of the Shinnecock Hills. Plant World 1:11, 12.

1899—Clute, Willard Nelson. Spring in the Shinnecock Hills. Plant World 2:53-55.

1743-50—Colden, Cadwallader. Plantae Coldenghamiae in Provincis nove boracensi americes sponte crescentes. Acta Soc. Sc. Upsal. 1743:81-136; 1749: 1744-50: 47-82. 1751.

1909—Collins, F. S. The Green Algae of North America. Tufts College Studies (Scientific series) Vol. 2, No. 3, Tufts College, Mass.

1912—Ibid. The Green Algae, of North America (Supplementary Papers). Tufts College Studies. Scientific Series Vol. 3. No. 2, Tufts College, Mass.

1918—Ibid. The Green Algae of North America (Second supplement). Tufts College Studies. Scientific Series. Vol. 4, No. 7. Tufts College, Mass.

1918—Ibid. A Working Key to the Genera of North American Algae. Ibid. Vol. 4. No. 8.

1913-23—Conard, H. S. "Revegetation of a Denuded Area," Botanical Gazette 55, 1913. 80-84: 75:414-420, 1923.

1924—Conard, H. S. Second Survey of the Vegetation of a Long Island Salt Marsh. Ecology 5:379-89.

1924—Conard, H. S. Belt Transect of Cold Spring Harbor Sandspit (Long Island, N. Y.) 1922. Ecology 5:259-61.

1905—Conn, H. W. The Protozoa of the Fresh Waters of Connecticut. Bull. No. 2, State of Connecticut Geological and Natural History Survey.

1908—Conn, H. W. and Webster, L. H. The Algae of the Fresh Waters of Connecticut. Bulletin No. 10, State of Connecticut Geological and Natural History Survey.

1857—Cook, G. H. On a Subsidence of the land on the sea coast of New Jersey and Long Island. Amer. Jour. Sci. II 24:341-354.

1895—Curtis, C. C. Some Interesting Features of Well Known Plants of N. Y. Harbor. Journ. N. Y. Microscopical Society. 11:63-73.

1914—Cushman, J. A. Desmids From Bronx Park, N. Y. Bull. Torr. Bot. Club. 30:573-14.

1912—Darling, Chester. Key to the Wild Herbs Flowering in the Spring. Torreya 12:46-65.

1898—Davenport, C. B. and Johnson, D. S. The Flora about Cold Spring Harbor. Science II, 8:687-688.

1903—Davenport, C. The Animal Ecology of the Cold Spring Sandspit, with Remarks on the Theory of Adaptation. Dec. Pub. Univ. Chicago, X: 157-176.

1910—Davis, C. A. Salt Marsh Formation near Boston and its Significance. Economic Geology V:631.

1893-1910—Davis, W. T. Botanical Notes. Additions to Lists of Staten Island Plants. Proc. Nat. Science Assoc. of Staten Island. April 1893; Oct. 14, 1893; 4:83 (1895). 8:5 (1901): 30-31 (1902:9:22, 23 (1904). Staten Island Association of Arts and Sciences Proc. 1:35-37 (1906). 2:161-62 (1910).

1902—Davis, W. T. Local Notes on Vanishing Wild Flowers. Nat. Science Assoc. of Staten Island Proc. 8:29-30.

1905—Davis, W. T. A New Station for the Hybrid Oak, Quercus brittoni Davis. Natural Science Association of Staten Island proc. 9:38. 1905.

1914—Davis, W. T. Additional Facts Concerning the Hybrid Oaks, Quercus nana x Quercus marylandica (Q. brittoni Davis). Staten Island Assoc. Proc. 4:110, 111.

1905—12. Dowell, Philip. Additions to the Flora of Staten Island. Nat. Science Assoc. Proc. 1:61-67. 1906. l.c. 3:163-68. 1912. (Notes on some Staten Island Forms.)

1910—Dowell, Phillip. The Violets of Staten Island. Torrey Club. Bull. 37. 163-79.

1895—Dyar, H. G. On Certain Bacteria from the Air of N. Y. City. Annals N. Y. Academy of Science 8:322-80.

1874—Eaton, D. C., and others. A catalogue of plants growing within 30 miles of Yale College. 72 p. Map. Published by Berzelius Society.

1807—Eddy, C. W. Plantae Plandomensis or a Catalogue of the Plants growing Spontaneously in the neighborhood of Plandome, the County residence of Samuel L. Mitchell. New York, Aug. 28, 1807. Med. Repos. II 5:123-131.

1896—Edwards, A. M. On the occurrence of Neocene marine Diatomaceae near N. Y. Amer. Nat. 30:212-16.

1923—Evans, A. M. Second revised list of New England Hepaticae Rhodora 25 p. 192-199.

1908—Evans, A. W. and Nichols, G. E. The Bryophytes of Connecticut. Bull No. 11. State of Connecticut Geological and Natural History Survey.

1919—Engler, A. and Gilg, E. Syllabus der Pflanzen familien. Gebruder Borntraeger, Berlin.

1900-1913—Engler, A. and Prantl, N. Die Natuerlichen Pflanzen familien, etc. Leipzig.

1882—Farlow, W. G. The Marine algae of New England. Appendix A. Rept. U. S. Commissioner for Fish and Fisheries for 1879 p. 1-210. Washington.

1893—Farlow, W. C. Notes on Algae of Long Island. Bull. Torrey Bot. Club. Vol. 20:107-09.

1922—Ferguson, W. C. "Some Interesting Plants from Long Island, N. Y.," Torreya 22.

1924—Ferguson, W. C. Contributions to the Flora of Long Island, N. Y., Bull. Torrey Bot. Club 51.

1925—Fish, C. J. Seasonal Distribution of the Plankton of the Woods Hole Region. Bureau of Fisheries, Doc. No. 975.

1900—Fisher, W. L. The Violets on Long Island. Plant World III: 91-22.

1914—Fuller, M. Geology of Long Island. U. S. G. S. Prof. Paper 82.

1910—Fink, Bruce, Lichens of Minnesota. U. S. National Herbarium. Vol. 14. Part I.

1912—Gager, C. Stuart. The First Botanic Garden on Long Island. Brooklyn Botanic Garden Record I:97-99.

1908—Gran, H. H. Diatomeen. Nordisches plankten. Botan. theil 146 pp. Lief 3. 19.

1880—Gratacap, L. P. The Botany of a City Square (Manhattan Square) Amer. Nat. 14: 1889-92. 1880.

1884—Gratacap, L. P. and Woodward, A. The Fresh Water Flora and Fauna of Central Park, N. Y. Scientific American Supplement. Dec. 27, 1884 p. 7480-81.

1896—Graves, C. B. Notes from Plum Island and Fisher's Island, N. Y. Bull. Torrey Club 23:59.

1910—Graves, C. B., Eames, E. H., Bissell, C. M., Andrews, L., Harger, C. B., Weatherby, C. A., Catalogue of the Flowering Plants and Ferns at Connecticut Growing without cultivation. Bull. No. 14, State of Connecticut Geological and Natural History Survey.

1908—Grays New Manual of Botany. Robinson, G. L. and Fernald, M. L. American Book Company, N. Y.

1923—Grier, N. M. Streams of Long Island. Science, N. S. LVIII. p. 86.

1923—Grier, N. M. Unreported Plants from Long Island. I. Pteridophyta and Spermatophyta. Torreya 24:71-76.

1923—Grier, N. M. Unreported Plants from Long Island, II, Cryptogams exclusive of Pteridophyta. Torreya :25.

1902—Grout, A. J. Additions to the Recorded Flora of Long Island. Torreya 2:49-53.

1916—Grout, A. J. The Moss Flora of N. Y. City and Vicinity. Published by the author, New Dorp, Staten Island, N. Y.

1823—Halsey, A. Synoptical View of the Lichens Growing in the Vicinity of the City of New York. Annals. Lyc. Nat. Hist. 1:3-21.

1905—Harper, R. M. Coastal Plain Plants in New England. Rhodora 7:69-80. Rhodora 8:27, 1906.

1907—Harper, R. M. A Long Island Cedar Swamp. Torreya 7: 198-201.

1908—Harper, R. M. The Pine Barrens of Babylon and Islip, Long Island, Torreya 8:1-9.

1912—Harper, R. M. The Hempstead Plains of Long Island. Torreya. 12:277-87. 1912. American Geographical Society. Bull. 43:351-60.

1917—Harper, R. M. "The Natural Vegetation of Western Long Island South of the Terminal Moraine." Torreya 17:1-13.

1917—Ibid, "The Native Plant Population of Northern Queens County, Long Island, Torreya 17:131-142.

1918—Ibid. "The Vegetation of the Hempstead Plains." Mem. Torrey Bot. Club 17:262-268.

1907—Harshberger, J. W. The Reclamation and Cultivation of Salt Marshes and Deserts. Bull. Geographical Society of Philadelphia V. 12-23. 4 figs.

1909—Harshberger, J. W. "Vegetation of Salt Marshes, etc., of Northern Coast of New Jersey." Proc. Acad. Nat. Science Phil. 1909:373-400.

1909—Harshberger, J. W. "Bogs, Their Nature and Origin." Plant World 12:34.

1912—Harshberger, J. W. An Hydrometric investigation of the Influence of Sea Water on the distribution of Salt Marsh and Estuarine Plants. Proc. Amer. Phil. Soc. L: 457-496.

1916—Harshberger, J. W. "Origin and Vegetation of Salt Marsh Pools." Proc. Amer. Phil. Soc. LV:481-84 5 Pl.

1916—Harshberger, J. W. "Vegetation of the New Jersey Pine Barrens." Christopher Sowar Co. Phil. 1916.

1919—Harshberger, J. W. and Burns, V. G. The Vegetation of the Hackensack Marsh. A typical American Fen. Trans. Wagner Free Institute of Science of Philadelphia IX. part I, p. 35. 14 fig.

1892—Hicks, Henry "Flora of Hempstead Plains" Thesis at Cornell University 1892. Copy in Brooklyn Botanic Garden.

1879-95—Hollick, C. A. and Britton, N. L., Flora of Richmond County, N. Y., 1879. Addenda by these authors and Davis, W. T., and Dowell, Phillip, *loc. cit.*, in Torrey Club Bull. 7:11-12 (1880); 8:48 (1881); 9:149-150, 12:38-40, 13: 83-84, 16:132-134 (1889); 18:213-14 (1891); 22: 460-62 (1895).

1887—Hollick, C. A. Staten Island Trees. Natural Science Association of Staten Island, Proc. Feb. 12, 1887.

1888—Hollick, C. A. and Davis, W. T. Hybrid Oaks on Staten Island. Proc. Nat. Science Association. Staten Island, 1888.

1888—Hollick, C. A. A Recent Discovery of Hybrid Oaks on Staten Island. Torrey Club Bull. 15:303-7. 1888. Reprinted Contribution No. 8, Herbarium, Columbia College.

1890—Hollick, C. A. and Britton, N. H. List of Staten Island Fungi in the Collection of the Association. Proc. Nat. Science. Assoc. of Staten Island, Special No. 11.

1891—Hollick, C. A. A trip to Montauk Point, Long Island. Torrey Club Bull., 18:255-256.

1893—Hollick, C. A. Plant distribution as a factor in the interpretation of geological phenomena, with special reference to Long Island and vicinity. Trans. N. Y. Acad. Sci. Vol. 12. p. 189-202.

1893—Hollick, A. Preliminary Contribution to our knowledge of the Cretaceous formation on Long Island and eastward. Trans. N. Y. Acad. Science, Vol. 12, p. 222-31.

1893—Hollick, A. A new fossil palm from the Cretaceous formation at Glen Cove, L. I., Bull. Torrey Bot. Club. 20:168-69.

1893—Hollick, A. Some further notes upon Serenopsis Kempii. Bull. Torrey Bot. Club 20:334-35.

1894—Hollick, A. Some further notes on the geology of the north shore of Long Island. Trans. N. Y. Acad. Science Vol. 13, 1894, p. 122-30. Discusses silicified Paleozoic fossils found in the drift at Lloyd Neck.

1894—Hollick, A. Additions to the Paleobotany of the Cretaceous formation of Long Island. Bull. Torrey Bot. Club. 21:49-65. Gives further discoveries of Cretaceous floras at Eaton, Lloyd, Oak necks, Glen Cove, Sea Cliff.

1894—Hollick, A. Recent investigations in the Cretaceous formation on Long Island, N. Y. Proc. Amer. Assoc. Adv. Science. Vol. 42. p. 175.

1890—Hollick, A. The Age of the Amboy clay series as indicated by its Flora. Am. Geologist 22:255-56 and Science N. S. Vol. 8, 1898. p. 467-468.

1898—Hollick, A. Geological Notes, Long Island and Block Island. Trans. N. Y. Acad Sci. Vol. 16, p. 9-18.

1899—Hollick, C. A. Notes on the Geology and Botany of the Fox Hills Golf Links. Proc. Nat. Science Association of Staten Island. Special No. 11.

1901—Hollick, C. A. A Recently Introduced Grass (Festuca capillata Lam.) Proc. Nat. Science Association of Staten Island 8:16-17. 1901.

1901—Hollick, C. A.—List of Fungi Collected at Tottenville, Oct. 4, 1890. Proc Nat. Science Association of Staten Island. 8:25. 1901.

1903—Hollick, A. Filed work during 1901 in the Cretaceous beds of Long Island. 55th Ann. Report N. Y. State Museum, 1903. p. 48-50. Gives a list of paleontological accessions from Glen Cove.

1904—Hollick, A. Additions to the Paleobotany of the Cretaceous formation on Long Island. II. Bull. N. Y. Bot. Garden, Vol. 3, p. 403-18.

1905—Hollick, A. The occurrence and origin of Amber in the Eastern United States Amer. Naturalist 39:137-145.

1906—Hollick, A. and Jeffrey, E. C. Affinities of Certain Cretaceous Plant Remains Commonly Referred to the Genera Dammara and Brachyphyllum. Amer. Nat. 40:187-215.

1906—Hollick, A. Origin of the Amber Found on Staten Island. Journal, N. Y. Bot. Garden 7:11-12.

1906—Hollick, A. A Fossil Forest Fire. Proc. Staten Island Assoc. Arts and Sciences I:21-23.

1906—Hollick, A. The cretaceous Flora of Southern N. Y. and New England. Mon. U. S. Geol. Survey. Vol. 50.

1909—Hollick, A. and Jeffery, E. C. Studies of Cretaceous Coniferous Remains from Kreischerville, N. Y. Mem. N. Y. Bot. Garden. Vol. 3, 1909.

1912—Hollick, A. Additions to the Palebotany of the Cretaceous Formation on Long Island. III. Bull. N. Y. Bot. Garden. Vol. 8, No. 28, p. 154-170.

1902—Hollick, D. G. Notes on our Common Stemless Blue Violets. Proc. Nat. Science Assoc. of Staten Island. 8:39. 1902.

1915—House, H. D. Notes on Local Floras: Suffolk County. New York State Mus. Bull. 176, p. 42-44.

1924—House, H. D. Annotated List of the Ferns and Flowering Plants of New York State. New York Bibliographies by counties. N. Y. State Museum Bulletin 254.

1914—Howe, M. A. Some Midwinter Algae of Long Island Sound. Torreya 14:97-101.

1910—Howe, R. H. Jr. Ramalina Montagnei De Not. on Long Island. Rhodora 12:7.

1913—Hoyt, W. D. Marine Algae of Beaufort, N. C., and Adjacent Regions. Bull. Bureau of Fishheries. Vol. 36, p. 371-556. 1917-18.

1875—Hoysradt, L. H. Catalogue of the Phaenogamous and Acrogenous plants growing without cultivation within 5 miles of Pine Plains, Dutchess Co., N. Y. 33 pages. Bull. Torrey Bot. Club. 6 supplements.

1891—Hulst, Rev. E. D. Notes from Long Island. Bull. Torrey Bot. Club. 18: 152-153.

1906—Jeffrey, E. C. The Wound Reaction of Brachyphyllum. Annals. Bot. 20:383-394.

1907—Jeffrey, E. C. Auracaripitys, a new Genus of Araucarians. Bot. Gaz. 44:435-44.

1908—Jeffrey, E. C. On the structure of the Leaf in Cretaceous Pines. Annals Bot. 22:207-220.

1890—Jelliffe, S. E. Plants of Prospect Park. Brooklyn Daily Eagle Almanac, p. 74. 1890.

1893—Ibid. Notes on the Flora of the Long Island. Science N. Y. Vol. 22.

1890—Jelliffe, S. E. Plants of Prospect Park, Brooklyn. Daily Eagle Almanac. p. 75-76.

1893—Jelliffe, Smith Ely. A preliminary list of the plants found in the Ridgewood water supply of the city of Brooklyn, King's County, N. Y. Bull Torrey Club. 20:243-246.

1894-95—Jelliffe, S. E. Cryptogamic Notes from Long Island. I. Bull. Torrey Club 21:266-268.—II. Bull. Torrey Club 21:489. (Hepaticae)—III. Bull. Torrey Club 22:274, 275. (Diatomaceae)

1899—Jelliffe, S. E. "The Flora of Long Island," Published by the author, 64 W. 56 St., New York City.

1913—Jennings, O. E. The Mosses of Western Pennsylvania. Published by the author, Pittsburgh, Pa.

1915—Johnson, D. S. and York, H. H. "Relation of Plants to Tide Levels," Carnegie Institution Publication No. 206.

1910-11—Johnson, D. W. Botanical Evidence of Coastal Subsidence. Science II, 32:721; II, 38:300.

1913—Johnson, D. W. Botanical Phenomena and the Problem of Recent Coastal Subsidence. Bot. Gaz. 56:449.

1898—Kalbfleisch, A. S. Orchids on Long Island. Plant World 1: 177-179.

1903—Kauffmann, P. The Passing of Port Morris. American Botanist 5:10-12.

1905—Kirby, James. Some Plants of the Hempstead Plains. American Botanist 7:110.

1857—Knieskern, P. D. A Catalogue of Plants growing without cultivation in the countries of Monmouth and Ocean New Jersey. 41 p. Trenton. Ann. Rept. Geol. Survey, N. J. Supplement.

1904—Kobbe, F. W. Notes on the Local Flora. Torreya 4: 68-69.

1921—Kofoid, C. A. and Swezy, Olive. The Free Living Unarmored Dinoflagellata. Mem. Univ. of California. Vol. 5.

1917—Latham, R. A. The Habitat of Cephalozia Franciscii on Long Island, N. Y. Bryologist XX:63-64.

1811—LeConte, John. Catalogus Plantarum Quas Sponte Crescentes in Insula Noveboraco. Observavit Johannes Le Conte. American Medical and Philosophical Register: 2:134-142.

1870-74—Leggett, W. E. (for Torrey Botanical Club). Revised Catalogue of Plants Growing within 30 Miles of New York City (to Gramineae) Bull. Torrey Bot. Club V. 1-5. 1870-74.

1918—Levy, D. J. A Station for Ephemerum near New York City. Bryologist 26:33.

1911—MacBride, T. H. North American Slime Molds. New and Revised Edition. Macmillan Co.

1912—MacVicar, I. M. Students Handbook of British Hepatics. V. T. Sumfield, Eastbourne.

1889—Martindale, I. C. Marine Algae of the New Jersey Coast and Adjacent Waters of Staten Island. Torrey Club Memoirs. 1:87-111.

1896—McDonald, W. H. New York Ballast Grounds and Solanum rostratum and Argemone mexicana (2 titles). Asa Gray Bulletin 4:65-66.

1897—McDonald, W. H. Botanical Collecting in the Vicinity of New York City. Asa Gray Bulletin 5:6-7. 1897.

1906—McFarland, J. H. The Trees of a Great City. Outlook 82: 203-13, 1906.

1831-32—Mead, S. B. A catalogue of plants growing spontaneously in the vicinity of North Salem Academy. Ann. Rep. Regents Univ. N. Y., 1831: 89:97., 1832: 101.

1872-73—Miller, E. S. Suffolk County Plants. Bull. Torrey Club 2:40. O. 1871; 3:56. 1872; 441-42. S. 1873.

1874-80—Miller, E. S., and Young, W. Catalogue of the Phaenogamous and Aerogenous Plants of Suffolk County, L. I. Wading River, and Aqueboque, P. O. W. H. Werton, Jr., and Co., Printer, Port Jefferson, L. I., 1874. Addenda in Torrey Club. Bull. 5:33-34 (1874): 6:155-57; 171-72 (1877). 6:258-259 (1878); 7:17-18 (1880).

1895—Newberry, J. S. The Flora of the Amboy Clays. Mon. U. S. Geol. Survey. Vol. 26.

1886—Newberry, J. S. Fossil Leaves in Staten Island and Long Island Clay Beds; Amer. Journ. Science, 3rd ser., Vol. 31, p. 403.

1919-23—Oudemanns, C. A. J. K. Enumeratio Systematica Fungorum. M. Nijhoff. The Hague.

1865—Paine, J. A. Catalogue of Plants found in Oneida County and Vicinity. Ann. Report. Cab. Nat. Hist., N. Y. 18:53-192; Cites localities from all parts of state except coastal islands.

1903—Peet, L. H. Trees and Shrubs of Prosepct Park, i-x, 1-237; New York.

1905—Peet, L. H. Trees and Shrubs of Central Park, N. Y., p. 1-363; New York.

1908—Paulson Ove. Peridinales. Nordisches plankton Botan. theil. 124 pp. 8, 18.

1868-1912—Pack, C. H. Contributions to the Botany of the State of N. Y. State Botanists Reports.

1886—Pike, Nicholas. Check list of marine algae, based on specimens collected on the shores of Long Island, from 1839 to 1885. Bull. Torrey Club 13:105-115.

1892—Col. Nicholas, P. K. "The Shrub and Trees of Prospect Park." Brooklyn Daily Eagle Almanac. 1892.

1888—Poggenburg, J. F. Britton, N. L., Sterns, E. E. Long Island Flora—Preliminary catalogue of Anthophyta and Pteridophyta reported as growing spontaneously within one hundred miles of New York City. Bull Torrey Botanical Club, 1888.

1894—Pollard, C. A. On Cretaceous leaves in water worn fragments, etc. Trans. N. Y. Acad. Sci. Vol. 13:180-81.

1887-92—Pychowska, L. D., Mrs. Suffolk County Long Island Plants. Named according to Grays Manual. Edition of 1889-1890. MSS. Hoboken, N. J.

1905—Reichling, G. A. Contribution to the recorded fungus and slime-mould flora of Long Island. Torreya 5:85-87.

1904—Jelliffe, S. E. "Additions to the Flora of Long Island." Torreya 4. 97-100.

1915—Rabenborst, L. (K. Muller). Kryptogamen Flora Vol. 6 (2) F. 138.

1917—Fink, Bruce. "Lichens of Minnesota" U. S. National Herbarium. Vol. 14. Part I.

1857—Rawolle, C. and Pilat, Ig. A. Catalogue of Plants gathered in August and September 1857 in the Ground of Central Park. 8vo. pamphlet, 34 pages.

1857—Report of the Engineer in Chief of Central Park. List of Trees and Shrubs in Central Park. p. 25-35.

1893—Ries, H. Notes on the clays of N. Y. state and their economic value. Trans N. Y. Acad. Sci. Vol. 12, p. 40-47.

1894—Ries, H. On the occurrence of cretaceous clays at Northport, L. I. School of Mines Quarterly, Vol. 15:354-55.

1894—Ries, H. Microorganisms in the Clays of New York. Tran. N. Y. Acad. Science. 13:167.

1880—Rudkin, W. H. Large Trees near N. Y. City. Torrey Club. Bull. 7:107-09.

1895—Rusby, H. H. Poisonous Plants of the Vicinity of N. Y. Alumni Journal, College of Pharmacy. 2:307-25.

1906—Rusby, H. H. Historical Sketch of the Development of Botany in New York City. Torreya 6:101-11; 133-45.

1882-1913—Saccardo, P. A. Sylloge Fungorum, Vol. I-XXII. Padua.

1898—Salisbury, R. D. Final Report Geol. Survey of New Jersey, 4:92.

1912—Scharff, R. F. Distribution and origin of life in North America. New York, 1912.

1887-89—Schultze, E. A. A Descriptive List of State Island Diatoms. Bull. Torrey Club. 14:69-93. 109-14 (1887); 16:98-104 (1887).

1917—Schwarze, C. A. Parasitic Fungi of New Jersey. N. J. Agr. Exp. Stat. Bull. 813. 226 p.

1911-18—Smith, A. L. A Monograph of the British Lichens. 2 Vol. British Museum Natural History, and Longmans, Green and Company.

1880—Stearns, W. A. List of Plants of Fishkill, N. Y. and Vicinity. 23 pages.

1888—Sterns, E. E. Cheilanthes vestita S. on N. Y. Island. Bull Torrey Bot. Club. 15:211.

1910—Stone, Whitmer. "Plants of Southern New Jersey with especial reference to the Flora of the Pine Barrens." Ann. Report N. J. State Museum. 25:828. Includes references to the northern vegetation of N. J.

1913—Summer, F. B., Osborn, R. C., Col. L. J. and Davis, B. M. A Biological Survey of the Waters of Woods Hole and Vicinity. Bull. U. S. Bureau of Fisheries for 1911. Vol. 31. Washington.

1909-11—Taylor, Norman. Local Flora Notes. Torreya 9:203-8. 257-61. 10:80-83; 145-49; 224-28, Bull. Torrey Bot. Club. 37; 429-35; 559-62; Torreya 11:33-36, 170-74, 186-89.

1915—Taylor, N. Growth-Forms of the Flora of New York and Vicinity. Amer. Journ. Bot. 2:23-31.

1915—Taylor, N. Flora of New York and Vicinity. A contribution to plant geography. (N. Y. Botanical Garden, Memoirs, Vol. 5).

1916—Taylor, N. Endemism in the Flora of the Vicinity of N. Y. Torreya 16:18-27. 1916. Contains bibliographies of Flora of adjoining states.

1923—Taylor, N. "Vegetation of Long Island." Part 1. Vegetation of Montauk. Mem. Brooklyn Bot. Garden. Vol. 2.

1910—Tilden, J. The Myxophyceae of North America and adjacent regions. Minnesota Algae Vol. I. Rept. of Survey. Botanical Series VIII. Minneapolis.

1819—Torrey, John, Eddy, C. W., Knevels, D. V. A Catalogue of Plants growing spontaneously within 30 miles of the City of New York. p. 100. Albany. Published by the Lyceum of Natural History of New York.

1840—Torrey, John. Catalogue of Plants of N. Y. State. Ann Report. Geol. Survey. N. Y. 4:117-197.

1843—Torrey, J. Flora of N. Y. State, Albany, N. Y. Contains a number of references to Long Island Plants. Constitutes part 2 of the Natural History of N. Y.

1903—Transeau, E. N. On the geographic distribution and ecological relations of the bog-plant societies in N. America Bot. Gaz. 36:401-420.

1908—Transeau, E. N. "Relation of Plant Societies to Evaporation" Bot. Gaz. 45:217-32.

1913—Transeau, E. N. The Vegetation of Cold Spring Harbor, L. I. The Littoral Successions. Plant World 16: p. 189.

1882—Todman, E. Synopsis of North American Lichens. Part I. 1882. Part II. 1888.

1884—Underwood, L. M. Descriptive Catalogue of North American Hepaticae North of Mexico. Bull. Illinois State Lab. of Natural History 2. 1-33.

1895—Vail, Anna Murray. The June Flora of a Long Island swamp. Garden and Forest 8:282, 283.

1896—Van Huerck, H. A. Treatise of the Diatomaceae. Transl. from the French by Wynne E. Master, 1896. Whaldom and Wesley, London.

1915—Walton, L. B. A Review of the described species of the order Euglenoidina Bloch, Ohio State University, Bulletin. Vol IX. No. 5.

1890—White, David. On Cretaceous Plants from Martha's Vineyard. Amer. Journ. Science, 3rd ser., Vol. 39, p. 93-101. Mentions occurrence of plant remains at Glen Cove, L. I.

1905—White, E. A. "Hymeniales of Connecticut." Bull No. 3. State of Connecticut Geological and Natural History Survey.

1910—White, E. A. Second Report on Hymeniales of Connecticut. Bull. No. 15, State Geological Natural History Survey.

1881—Willis, O. R. Report on the Flora of Westchester County. In Bolton, Robt., The History of the several towns, manors and patents of the County of Westchester (Ed. 2) I:771-826. Also issued separately with a sheet of errata and additions. Additions by E. G. Britton, Bull. Torr. Club. 13:617, and by E. H. Day. Bull. Torrey Club 13:94-95.

1906—Veatch, A. C. and others. Underground Water Resources of Long Island, N. Y. U. S. Geol. Survey Prof. Paper 44.

1905—Wood, George Clayton. Additions to the lichen flora of Long Island. Bryologist 8:51.

1914—Wood George Clayton. A preliminary list of the lichens found within a radius of 100 miles of New York City. Torreya 14:73-95.

1873—Young, Henri Wilson. Suffolk County plants. Bull. Torrey Club 3:51, 52. N 1872; 4:41. S 1873.

1835—Zabriskie, J. B. Catalogue of Plants, Indigenous and Cultivated, in the vicinity of Erasmus Hall. 48 Ann. Report of Regents Univ. N. Y. 176-181.

THE RELATIONS OF VEGETATION TO BIRD LIFE IN TEXAS.

HARRY C. OBERHOLSER.

INTRODUCTORY.

The present paper was originally intended as a part of the author's still unpublished treatise on the birds of Texas. It has, however, outgrown its place in the introduction of that report. The data set forth in the following pages were gathered by the various naturalists of the Biological Survey in the course of many years of zoological exploration in all parts of Texas. No one more than the writer regrets the limitations of treatment, which are for various reasons necessary. We have tried, however, with the information at our disposal, to prepare an outline of the ecological areas in various parts of this State, leaving the details to be gathered by future investigators. Since the probabilities of our returning to this field are slight, it seems worth while, with this explanation, to place on record what information we now possess.

A word should be added concerning our use here of the term "association." The groupings of associations are intended to be largely geographic, and therefore small associations, even though strictly ecological, have in many instances been included in the larger areas. In such cases our "associations" are technically equivalent to "formations," but since we give characteristics of each area, it will be easy for the reader to ascertain which are strictly associations and which belong to the more inclusive category.

The writer is indebted to Mr. Paul C. Standley, of the United States National Museum, for the verification of all plant names in this paper and to Dr. H. H. T. Jackson for a number of helpful suggestions.

RELATIONS OF VEGETATION TO BIRD LIFE.

All animal life is either directly or indirectly dependent on vegetation for its existence. The more direct this dependence the more obvious, of course, is the relationship. This relationship may be expressed in terms of either physiographical or of physiological ecology. It is evident from even a superficial study that vegetation, other things being equal, is one of the most potent influences in the distribution of birds, upon whatever the distribution of vegetation itself may depend. Thus vegetation, aside from its direct influence in providing food and suitable environment, has indirect influence through hindering or facilitating the presence of enemies, and in many ways affecting the supply and distribution of moisture. We must look, therefore, in explanation of the peculiar distribution of certain birds, to the often concomitant differences in vegetation. What is, in this way, true in Texas, is doubtless so in other regions. The influence of vegetation on bird life is, however, probably not so fundamental as either temperature or humidity, because these, in addition to their direct effect upon the bird, determine also directly the presence, distribution, and character of vegetation itself.

That this relationship between vegetation and bird life is of great importance from an economic as well as from a purely scientific standpoint is indisputable. It must be taken into account in all questions of the introduction of species, since certain birds will not thrive unless the environment of vegetation is suited to their needs; and an attempt such as the introduction of a strictly forest bird into an arid desert is, of course, futile. In attracting birds to our homes, if the attempt is to be at all permanently satisfactory, due regard must be had to the planting of suitable trees and shrubs, for in both a natural state as well as under artificial conditions it is perfectly evident that vegetation has direct and important bearing on the protection and even the very preservation of bird life.

Vegetation influences bird life and its distribution in several ways. Its effect on the food supply is probably to be regarded as most important, since all animals, including in-

sects, must be nourished by vegetation or by other animals that feed on vegetation. In this connection should be emphasized the important part borne by insects in the economy of birds. Most insects feed directly on vegetation, all at least indirectly; and since birds to a great extent eat insects, they are thus indirectly dependent on vegetation for this part of their diet. Seeds furnish by far the greater part of the nourishment derived by birds directly from plants, since they contain highly concentrated nutritive elements. Other portions of plants, however, principally the leaves, and in many cases bulbous roots, are important articles of diet. An abundance of plant food naturally attracts birds; a paucity repels them; for while some birds are able to sustain life and strength for comparatively long periods without food, and often live in places where food is scarce and hard to obtain, yet most birds require large quantities of nutriment at frequent intervals, making necessary a living area which permits ready access to a bountiful food supply.

Next to food, probably suitable nesting places constitute the most important elological factor in a bird's existence, since without proper places for rearing its young the species would soon become extinct. The disastrous effects of the destruction of nesting places, or the prevention, from any cause, of access by the birds to their accustomed breeding places, has many times been exemplified. Birds that build nests in trees, or bushes, or on the ground among the grass, are most dependent upon vegetation. The matter of nesting, however, is not, as is the case with food, dependent fully on plants, since many kinds of nesting sites are admirably suited to the needs of birds, although without the direct assistance of any kind of vegetation. Man can often very materiailly assist the birds by providing suitable nesting places.

Suitable shelter, aside from that required for reproduction, is also an important factor in the well-being of bird life. This may readily be shown by a mere recital of the great destruction that occasionally takes place when birds are caught without shelter in storms at sea; in blizzards on the prairie; or are overtaken by any similar catastrophes. Here too, as in the case of nesting sites, vegetation is not responsible for all, but exercises, nevertheless, a very im-

portant influence. The cover afforded by forests, thickets, marshes, swamps, heavy grass, and the cavities in the branches or trunks of trees, are good examples of the shelter with which vegetation provides the birds.

Also by providing habitats suited to the various species, vegetation affects the welfare of birds, though probably in less degree than in the other ways already mentioned. It is well known that birds having food, proper nesting places, and shelter still evince a preference for certain kinds of habitats. Birds often consistently prefer particular locations over others that are apparently just as desirable; as, for instance, the case of the purple martin, which appropriates a certain nesting box year after year, and just as persistently refuses others only a short distance away. Of course, suitable habitats are to a considerable degree often made so by the fact that they furnish food, nesting places, or shelter, but, doubtless, in addition to all these there is in most cases the added consideration of purely individual preference on the part of the bird. This applies as well to winter homes as to those of summer.

METHOD OF TREATMENT.

Our purpose now is to show the very intimate relation of the bird life of Texas to its environment of vegetation. The following scheme of ecological distribution is intended to show, in so far as *Texas* is concerned, the relative associations of birds and the difference in the avifauna of the various areas in the State. Owing to the limits of the present treatise this has not in most cases been carried to its greatest possible refinement, but is intended to show in a somewhat *general* way what birds and plants are to be found in given environments; hence *nearly all of the areas given are capable of further subdivision.* We have for this purpose divided Texas into its most salient physiographic sections, and these, it should be noted, have no *necessary* correlation with the faunal areas and life zones of the state. These sections we have further divided into their most important vegetation areas. The resulting ecological associations are here treated with regard to their relations to each

other, and particlarly with regard to the ecological relations of their *birds* and *plants*. It is apparent that many of these ecological associations correspond very closely in general character of vegetation to others in different physiographic sections of the State, and in these cases the differences in flora and fana are evidently due to temperature, humidity, and similar concomitant influences.

The plant lists for the various areas are, of course, only partial, but are intended to give an idea of the botanical facies of each; and, together with the lists of birds, to show what combinations of plants and birds are found associated. For lack of conclusive data, no distinction is here made between plants that are *characteristic* of a single association and those that occur in several. Species of very rare occurence are marked (R). Comparison of these lists will show, therefore, upon what combination of plants any given combination of bird is dependent. A few areas that are practically without vegetation are included, to exhibit the resultant paucity or bird life. Material change in the vegetation of an area will be followed by a corresponding change in the avifauna; and a complete transformation of the plants of one association into that of another will bring about a like transformation in the bird life.

One or two points it may be well to note with regard to the general distribution of birds in this region. Wide ranging species like hawks, vultures, some shore birds, and a few others, occur in practically any environment, and but few of all the birds of the State are confined to any single ecological association. The result then is, as in plants, sets of species made of partly the same species with the loss of some and the presence of some others as compared with any other given area. The proximity of two greatly differing plant areas has often a marked effect on the avifauna of both. For example, a marsh furnishes nesting places for many species that feed along an adjoining beach or in cultivated areas, which birds would not be there in the summer were it not for the continguity of the suitable nesting area. Likewise the absence of suitable nesting sites in adjacent areas will in many cases cause the absence of certain species in a given area. The various lists of birds are intended to

include all those that occur regularly in summer, *without regard to actual breeding within the area;* neither is any distinction made in the case of very local species, whose ranges do not completely fill the particular area under consideration. Furthermore, we have omitted from the lists all but summer birds, all that occur but accidentally, all extinct species, and all those of casual or very irregular occurrence. Species which are of very rare though regular occurrence are followed by (R). No other attempt is here made to indicate the strictly *characteristic* birds.

ECOLOGICAL ASSOCIATIONS OF BIRDS AND PLANTS IN TEXAS.

Gulf Shore Association.

This area consists of the beaches of the Gulf of Mexico and its bays, together with the sandy islands along the coast, and the tide-flats bordering the various lagoons and inlets. Its characteristics are great stretches of sand and mud-flats. The vegetation is mostly sparse, and is made up principally of low grasses and annuals with, in places, scattered bushes. The birds are mostly waterfowl and shore birds, many of which nest on the sand.

The list of plants follows:

Cenchrus carolinianus
Chaetochloa macrosperma
Eleusine indica
Eragrostis hypnoides
Leptochloa fascicularis
Monanthochloe littoralis
Panicum capillare
Paspalum distichum
Paspalum vaginatum
Sporobolus virginicus
Triplasis americana
Triplasis purpurea
Uniola paniculata
Cyperus tetragonus
Eleocharis torreyana
Psilocarya nitens
Sisyrinchium exile
Sisyrinchium helleri
Sida ciliaris
Sida helleri
Tamarix gallica
Opuntia engelmanni
Opuntia humifusa
Meriolix serrulata drummondii
Raimannia drumondii
Samolus alyssoides
Bumelia lanuginosa
Sabbatia calycina
Cressa truxillensis
Ipomoea dissecta
Ipomoea littoralis
Ipomoea pescaprae
Phlox drummondii
Phacelia laxa
Heliotropium curassavicum
Lycium carolinianum

Populus deltoides (R)
Salix nigra
Quercus breviloba
Donalia intermedia
Donalia linearis
Salicornia perennis
Batis maritima
Tissa marina
Cakile geniculata
Prosopis glandulosa
Vachellia farnesiana
Canavalia obtusifolia
Xanthoxylum fagara
Castela nicholsonii
Vitis candicans
Vitis aurihaea
Gossypium religiosum
Physalis elliottii
Physalis viscosa
Solanum elaeagnifolium
Mecardonia viridis
Tubiflora acuminata
Cephalanthus occidentalis
Houstonia salina
Iva frutescens
Xanthium glabratum
Baccharis halimifolia
Borrichia frutescens
Cirsium horridulum
Erigeron myrionactis
Erigeron repens
Isocoma drummondii
Siderauthus phyllocephalus

The birds of this area are as follows:

Phalacrocorax vigua mexicanus
Anhinga anhinga
Fregata magnificens rothschildi
Pelecanus fuscus fuscus
Pelecanus erythrorhynchos
Nyctanassa violacea
Nycticorax nycticorax naevius
Butorides virescens virescens
Florida caerulea caerulea
Dichromanassa rufescens
Hydranassa tricolor ruficollis
Leucophoyx thula thula
Casmerodius alba egretta
Ardea herodias wardi
Mycteria americana
Guara alba
Plegadis guarauna
Ajaia ajaja
Anas fulvigula maculosa
Coragyps urubu urubu
Cathartes aura septentrionalis
Tachyeriorchis albicaudatus sennetti (R)
Haliaeetus leucocephalus leucocephalus
Accipiter cooperii (R)
Accipiter velox (R)
Circus cyaneus hudsonius (R)
Pandion haliaetus carolinensis (R)
Haematopus palliatus palliatus
Squatarola squatarola cynosurae
Oxyechus vociferus vociferus
Charadrius melodus (R)
Pagolla wilsonia wilsonia
Arenaria interpres morinella
Numenius americanus americanus (R)
Limnodromus griseus griseus
Limnodromus griseus scolopaceus
Totanus melanoleucus (R)
Catoptrophorus semipalmatus semipalmatus
Himantopus mexicanus
Larus atricilla megalopterus
Gelochelidon nilotica aranea
Hydroprogne caspia imperator
Thalasseus maximus
Thalasseus sandvicensis acuflavida
Sterna forsteri
Sterna hirundo (R)
Sternula albifrons antillarum
Sterna fuscata fuscata (R)
Rhyncops nigra
Streptoceryle alcyon alcyon
Otocoris alpestris grandi
Corvus brachyrhynchos paulus
Hirundo rustica erythrogastris
Stelgidopteryx serripennis serripennis
Progne subis subis

Salt Marsh Association.

This is made up of the great salt marshes and salt meadows bordering the bays, inlets, lagoons, and river mouths of the coast, exclusive of the actual bare shore areas. Its most conspicuous vegetation consists of close-standing cattails (*Typha latifolia*), rushes, and sedges; or of closely matted marsh grasses. The birds are waterfowl and such land birds as are more or less dependent on the marsh vegetation for nesting or feeding grounds. Its plants are as follows:

Typha latifolia
Potomogeton pectinatus
Ruppia maritima
Zostera marina
Sagittaria lancifolia
Vallisneria spiralis
Distichlis spicata
Leptochloa fascicularis
Leptochloa floribunda
Monanthochloe littoralis
Spartina cynosuroides
Spartina glabra
Spartina potens
Zizania palustris
Cladium effusum
Cyperus pseudovegetus
Cyperus speciosus
Eleocharis cellulosa
Eleocharis rostellata
Fimbristylis castanea puberula
Scirpus americanus
Scirpus nanus
Scirpus olneyi
Scirpus rubustus
Juncus roemerianus
Juncus setaceus
Sisyrinchium exile
Dondia intermedia
Dondia linearis
Salicornia bigelovii
Salicornia perennis
Batis maritima
Ranunculus pusillus
Amorpha paniculata
Vigna repens
Hibiscus moscheutos
Kosteletzkia althaeifolia
Lythrum lineare
Isnardia natans
Ptilimnium capillaceum
Limonium limbatum
Samolus ebracteatus
Samolus floribundus
Eustoma russellianum
Seutera palustris
Lycium carolinianum (R)
Agalinis fasciculata
Agalinis maritima
Baccharis angustifolia
Borrichia frutescens
Pluchea camphorata
Solidago augustifolia
Solidago sempervirens

The birds are:

Colymbus dominicus brachypterus
Phalacrocorax vigua mexicanus
Pelecanus fuscus fuscus
Fregata magnificens rothschildi
Ixobrychus exilis exilis (R)
Numenius americanus americanus (R)
Limnodromus griseus griseus
Limnodromus griseus scolopaceus
Totanus melanoleucus

Botaurus lentiginosus (R)
Nyctanassa violacea
Nycticorax nycticorax naevius
Butorides virescens virescens
Florida caerulea caerulea
Dichromanassa rufescens
Hydranassa tricolor ruficollis
Leucophoyx thula thula
Casmerodius alba egretta
Ardea herodias wardi
Mycteria americana
Guara alba
Plegadis guarauna
Ajaia ajaja
Querquedula discors (R)
Anas fulvigula maculosa
Dendrocygna bicolor
Dendrocygna autumnalis
Coragyps urubu urubu
Cathartes aura septentrionalis
Haliaeetus leucocephalus leucocephalus
Accipiter cooperii (R)
Accipiter velox (R)
Circus cyaneus hudsonius (R)
Pandion haliaetus carolinensis (R)
Fulica americana (R)
Gallinula chloropus cachinnans
Porphyrula martinica
Rallus longirostris saturatus
Squatarola squatarola cynosurae
Oxyechus vociferus vociferus
Catoptrophorus semipalmatus semipalmatus
Himantopus mexicanus
Larus atricilla megalopterus
Gelochelidon nilotica aranea
Hydroprogne caspia imperator (R)
Thalasseus maximus (R)
Thalasseus sandvicensis acuflavida (R)
Sterna forsteri
Sterna hirundo (R)
Sternula albifrons antillarum (R)
Streptoceryle alcyon alcyon
Tyrannus tyrannus tyrannus
Telmatodytes palustris thryphilus
Corvus brachynchos paulus
Hirundo rustica erythrogastris
Stelgidopteryx serripennis serripennis
Progne subis subis
Geothlypis trichas trichas
Agelaius phoeniceus phoeniceus (=*floridanus*)
Agelaius phoeniceus megapotamus
Megaquiscalus major major
Megaquiscalus major macrourus
Quiscalus quiscula aeneus
Molothrus ater obscurus
Peucaea botterii botterii (R)
Thryospiza maritima fisheri
Thryospiza maritima sennetti

Coast Prairie Grass Association.

This covers the dry or moist open grassy areas of the prairies of the coast region, excluding their ponds, marshes, swamps, woods, and thickets. The characteristic vegetation is a floor of grasses, mixed with numerous herbaceous plants, mostly annuals, and in some places with an occasional isolated low bush or cactus. The characteristic birds are such as frequent open grassy land where they find such cover and nesting opportunities as the herbaceous vegetation affords.

Its principal plants are included in the following list:

Ophioglossum crotalophoroides
Ophioglossum vulgatum
Tithymalus obtusatus
Callirrhoe involucrata

Agrostis hyemalis
Alopecurus geniculatus
Andropogon glomeratus
Aristida intermedia
Bouteloua barbata
Chaetochloa geniculatu
Chaetochloa lutescens
Festuca octoflora
Hordeum nodosum
Panicum agrostoides
Panicum anceps
Panicum dichotomiflorum
Panicum geminatum
Panicum gymocarpon
Panicum hians
Panicum reptans
Panicum scoparium
Panicum texanum
Paspalum floridanum
Paspalum pubiflorum
Phalaris caroliniana
Poa arachnifera
Sphenopholis obtusata
Sporobolus argutus
Carex brittoniana
Carex microdonta
Carex triangularis
Rhynchospora indianolensis
Comelina acrispa
Tradescantia gigantea
Tradescantia micrantha
Allium mutabile
Nothoscordum striatum
Yucca treculeana
Hypoxis hirsuta
Herbertia watsonii
Nemastylis coelestina
Sisyrinchium angustifolium
Ibidium reverchonii
Silene subciliata
Delphinium carolinianum
Ranunculus muricatus
Ranunculus trachyspermus
Thalictrum texanum
Argemone platyceras
Argemone rosea
Lesquerella pallida
Morongia uncinata
Callirrhoe pedata
Spaeralcea lindheimeri
Ascyrum hyperiocoides
Ascyrum multicaule
Ascyrum stans
Opuntia engelmanii
Opuntia humifusa
Gaura lindheimeri
Hartmannia speciosa
Hartmannia tetraptera
Kneiffia linifolia
Kneiffia spathulata
Meriolix drummondiana
Raimannia laciniata
Cynosciadium pinnatum
Phellopterus macrorhizus
Centaurium calycosum
Centaurium texense
Eustoma russellianum
Sabbatis campestris
Asclepias emoryi
Asclepiodora decumbens
Convolvulus hermannioides
Evolvulus sericeus
Phlox drummondii
Lantana camara
Verbena ciliata
Verbena xutha
Brazoria scutellarioides
Monarda citriodora
Scutellaria pilosa
Nicotiana trigonophylla
Solanum elaeagnifolium
Solanum triquetrum
Castilleja indivisa
Veronica peregrina
Ruellia ciliosa
Plantago purshii
Plantago virginica
Galium trifidum
Houstonia angustifolia
Valerianella amarella
Lobelia halei
Krigia virginica
Pyrrhopappus carolinianus
Serinea oppositifolia
Aphanostephus skirrobasis
Aster vernalis

Chamaecrista procumbens
Krameria secundiflora
Astragalus distortus
Baptisia leucophaea
Baptisia spaerocarpa
Cracca lindheimeri
Galactia canescens
Galactia marginalis
Indigofera leptosepala
Lathyrus pusillus
Lupinus subcarnosus
Medicago maculata
Psoralea rhombefolia
Trifolium carolinianum
Vicia ludoviciana
Zornia tetraphylla
Geranium carolinianum
Linum multicaule
Linum rigidum
Acalypha radians
Cnidoscolus stimulosus
Croton texensis
Stillingia sylvatica
Bellis integrifolia
Cirsium horridulum
Coreopsis coronata
Coreopsis nuecensis
Coreopsis similis
Erigeron tenuis
Evax prolifera
Filago nivea
Gaillardia pulchella
Gnaphalium purpureum
Grindelia microcephala
Helenium microcephalum
Hymenopappus artemisiaefolius
Isopappus divaricatus
Mesadenia tuberosa
Ratibida columnifera
Rudbeckia hirta
Senecio ampullaceus
Senecio lobatus
Senecio vulgaris
Sideranthus aureus
Silphium scaberrimum
Verbesina encelioides

Here are found the following birds:

Ardea herodias wardi
Dendrocygna bicolor
Dendrocygna autumnalis
Coragyps urubu urubu
Carthartes aura septentrionalis
Rhynchofalco fuscocoerulescens septentrionalis
Polyborus cheriway auduboni
Buteo borealis borealis
Buteo swainsoni (R)
Tachytriorchis albicaudatus sennetti
Haliaeetus leucocephalus leucocephalus
Accipiter cooperii (R)
Accipiter velox (R)
Circus cyaneus hudsonius (R)
Elanus leucurus majusculus (R)
Elanoides forficatus forficatus (R)
Pandion haliaetus carolinensis (R)
Meleagris gallopavo silvestris (R)
Tympanuchus americanus attwateri
Chaemepelia passerina pallescens (R)
Speotyto cunicularia hymugaea
Otus asio asio (=*floridanus*)
Otus asio mccallii
Strix varia alleni
Strix varia helveola
Tyto alba pratincola
Nyctidromus albicollis merrilli
Chordeiles minor chapmani
Archilochus colubris
Chaetura pelagica
Tyrannus tyrannus tyrannus
Muscivora forficata
Otocoris alpestris giraudi
Mimus polyglottos polyglottos
Mimus polyglottos leucopterus
Sialia sialis sialis
Corvus brachyrhynchos paulus
Hirundo rustica erythrogastris
Stelgidopteryx serripennis serripennis
Progne subis subis

Colinus virginianus virginianus
Rallus longirostris saturatus
Oxyechus vociferus vociferus
Numenius americanus americanus (R)
Catoptrophorus semipalmatus semipalmatus
Himantopus mexicanus
Larus atricilla megalopterus
Gelochelidon nilotica aranea
Hydroprogne caspia imperator (R)
Thalasseus maximus (R)
Thalasseus sandvicensis acuflavida (R)
Sterna forsteri
Sterna hirundo (R)
Sternula albifrons antillarum (R)
Zenaidura macroura marginella
Geothlypis trichas trichas
Sturnella magna argutula
Sturnella magna hoopesi
Agelaius phoeniceus phoeniceus (=*floridanus*)
Agelaius phoeniceus megapotamus
Megaquiscalus major major
Megaquiscalus major macrourus
Quiscalus quiscula aeneus
Molothrus ater obscurus
Peucaea botterii botterii (R)
Thryospiza maritima fisheri
Thryospiza maritima sennetti
Ammodramus savannarum bimaculatus
Chondestes gramacus strigatus
Spiza americana
Passer demosticus domesticus

Coast Prairie Thicket Association.

This includes the thickets on the coast prairies, both those along the streams and those on drier ground; also the scattered groves of trees and the thin fringes of timber along the streams. The dominant vegetation is therefore shrubby or arboreal. The characteristic birds are, as would be expected, bush- or tree-inhabiting species, for these find here abundant shelter and meeting sites as well as a plentiful food supply in the fruit of the bushes and trees and in the insects that such vegetation attracts. Only the northeastern part of the coast prairie is included in this association, since farther southwest it is in many places practically indistinguishable ecologically from the chaparral belt. The character of the vegetation of the Coast Prairie Thicket Association may be seen from the subjoined list of plants.

Pinus echinata
Pinus palustris
Pinus taeda
Elyonurus tripsacoides
Panicum helleri
Panicum polyanthes
Carex retroflexa
Carex styloflexa
Carex texensis
Meibomia paniculata
Meibomia pauciflora
Meibomia sessiliflora
Zanthoxyhum clavaherculis
Zanthoxylum faraga
Castela nicholsonii
Polygala hookeri
Polygala mariana
Bernardia myricaefolia

Cyperus hochstetteri
Cyperus stenolepis
Dichromena latifolia
Eriocaulon texense
Xyris ambigua
Xyris baldwiniana
Tradescantia micrantha
Dendropogon usneoides
Tillandsia recurvata
Yucca treculeana
Smilax laurifolia
Smilax renifolia
Agave americana
Populus deltoides
Salix nigra
Cerothamus cerifera
Hicoria glabra
Hicoria pecan
Quercus breviloba
Quercus marylandica
Quercus muhlenbergii
Quercus nigra
Quercus stellata
Quercus texana
Celtis mississippiensis
Momisia pallida
Ulmus americana
Ulmus crassifolia
Morus rubra
Toxylon pomiferum
Phoradendron flavescens
Viorna reticulata
Odostemon trifoliolatus
Persea borbonia
Platanus occidentalis
Rosa setigera
Rubus trivialis
Crataegus viridis
Acacia amentaoea
Morongia uncinata
Prosopis glandulosa
Vachellia farnesiana
Parkinsonia aculeata
Krameria secundiflora
Amorpha fruticosa
Baptisia nuttaliana
Meibomia bracteosa
Phyllanthus carolinensis
Stillingia sylvatica
Tithymalus obtusatus
Rhus copallina
Toxicodendron radicans
Toxicodendron toxicodendron
Ilex cassine
Ilex decidua
Condalia obovata
Zizyphus obtusifolius
Acer negundo
Parthenocissus quinquefolia
Vitis candicans
Vitis cinerea
Tilia americana
Tamarix gallica
Opuntia englemanii
Opuntia humifusa
Opuntia leptocaulis
Cornus asperifolia
Batodendron arboreum
Brayodendron texanum
Diospyros virginiana
Bumelia lanuginosa
Phlox detonsa
Phlox tenuis
Lippia ligustrina
Dracocephalum virginianum
Capsicum baccatum
Lycium carolinianum
Solanum triquetrum
Buchnera elongata
Veronica serpyllifolia
Campsis radicans
Cephalanthus occidentalis
Galium trifidum
Sambucus canadensis
Symphoricarpos symphoricarpos
Viburnum molle
Ibervillea lindheimeri
Aster purpuratus
Borrichia frutescens
Chrysopsis nuttallii
Helenium fimbriatum
Helianthus ciliaris
Leucosyris spinosus
Ratibida picta

The birds are as follows:

Anhinga anhinga
Nyctanassa violacea
Nycticorax nycticorax naevius
Butorides virescens virescens (R)
Florida caerulea caerulea (R)
Leucophoyx thula thula
Casmerodius alba egretta (R)
Dendrocygna bicolor
Coragyps urubu urubu
Cathartes aura septentrionalis
Buteo borealis borealis
Buteo lineatus alleni
Buteo platypterus platypterus (R)
Haliaeetus leucocephalus leucocephalus
Accipiter cooperii (R)
Accipiter velox (R)
Ictinia misisippiensis
Elanus leucurus majusculus (R)
Elanoides forficatus forficatus (R)
Pandion haliaetus carolinensis (R)
Meleagris gallopavo silvestris (R)
Colinus virginianus virginianus
Zenaidura macoura marginella
Coccyzus americanus americanus
Colaptes auratus auratus (R)
Centurus carolinus
Melanerpes erythrocephalus erythrocephalus
Phloeotomus pileatus pileatus
Phrenopicus borealis
Dryobates pubescens pubescens
Dryobates villosus audubonii
Bubo virginianus virginianus
Otus asio asio (=*floridanus*)
Strix varia alleni
Tyto alba pratincola
Antrostomus carolinensis
Phalaenoptilus nuttallii nuttallii
Chordeiles minor chapmani
Archilochus colubris
Horizopus virens
Empidonax virescens
Myiarchus crinitus crinitus
Tyrannus tyrannus tyrannus
Muscivora forficata
Mimus polyglottos polyglottos
Sialia sialis sialis
Polioptila caerulea caerulea
Thryothorus ludovicianus ludovicianus
Penthestes carolinensis carolinensis
Corvus brachyrhynchos paulus
Viero bellii bellii
Vereo griseus griseus
Lanivireo flavifrons
Vireasylva olivacea
Icteria virens virens
Geothlypis trichas trichas
Dendroica dominica albilora
Dendroica aestiva aestiva (R)
Compsothlypis americana ramalinae
Mniotilta varia (R)
Afelaius phoeniceus phoeniceus
Icterus galbula (R)
Icterus spurius
Megaquiscalus major major
Quiscalus quiscula aeneus
Molothrus ater obscurus
Piranga rubra rubra
Richmondena cardinalis magnirostris
Guirace caerulea caerulea
Passerina ciris ciris
Spizella passerina passerina
Chondestes grammacus strigatus
Spiza americana

Coast Priarie Aquatic Association.

This is made up chifly of the coast prairie fresh water ponds and their margins, but includes also the actual water and the muddy grassy margins of the various streams

and ditches that intersect the prairie land, together with the extensive rice fields. Its characteristic vegetation consists of various rushes, sedges, grasses, and such plants as thrive in wet or very moist situations. The bird life reflects the character of this environment and comprises chiefly waterfowl, shore birds, and such species as prefer the combination of water and low herbaceous vegetation.

Plants that grow in this association are:

Typha angustifolia
Typha latifolia
Naias guadalupensis
Potamogeton angustifolius
Potamogeton hybridus
Potamogeton lucens
Potamogeton pectinatus
Ruppia maritima
Alisma subcordatum
Echinodorus cordifolius
Echinodorus radicans
Echinodorus tenellus
Sagittaria graminea
Sagittaria papillosa
Sagittaria platyphylla
Vallisneria spiralis
Limnobium spongia
Chaetochloa geniculata
Chaetochloa magna
Echinochloa crusgalli
Eragrostis glomerata
Erianthus strictus
Homalocenchrus hexandrus
Homalocenochrus oryzoides
Manisuris rugosa
Oryza sativa
Panicularia nervata
Panicum gymnocarpon
Panicum hians
Panicum scabriusculum
Paspalum conjugatum
Paspalum dissectum
Tripsacum floridanum
Paspalum monastachyum
Paspalum praecox
Paspalum repens
Phragmites phragmites
Uniola latifolia
Eleocharis interstincta
Eleocharis macrostachya
Eleocharis mutata
Eleocharis obtusa
Eleocharis rostellata
Eleocharis tenuis
Eleocharis torreyana
Eleocharis tortilis
Eleocharis tuberculosa
Eleocharis vivipara
Fimbristylis autumnalis
Fimbristylis castanea
Fimbristylis laxa
Fimbristylis vahlii
Kyllinga brevifolia
Kyllinga pumila
Psilocarya nitens
Rhynchospora oligantha
Scirpus carinatus
Scirpus eriophorum
Scirpus hallii
Scirpus lineatus
Seleria oligantha
Acorus calamus
Pistia stratiotes
Spirodela polyrrhiza
Wolffiella floridana
Eriocaulon compressum
Eriocaulon septangulare
Xyris iridifolia
Mayaca aubletii
Commelina hirtella
Heteranthera dubia
Heteranthera limosa
Heteranthera reniformis
Pondeteria cordats
Juncus elliottii
Juncus filipendulus

Zizania palustris
Zizaniopsis miliacea
Carex frankii
Carex lupulina
Carex lurida
Carex microdonta
Cladium effusum
Cyperus articulatus
Cyperus cephalanthus
Cyperus erythrorhizos
Cyperus esculentus
Cyperus ferax
Cyperus haspan
Cyperus helvus
Cyperus iria
Cyperus pseudovegetus
Cyperus stenolepis
Cyperus strigosus
Dulichium arundinaceum
Eleocharis albida
Eleocharis arenicola
Eleocharis cellulosa
Eleocharis elongata
Eleocharis glaucescens
Juncus repens
Juncus texanus
Thalia barbata
Crinum americanum
Hymenocallis galvestonensis
Sisyrinchium augustifolium
Brasenia purpurea
Cabomba caroliniana
Castalia ampla
Castalia elegans
Castalia mexicana
Nymphaea puberula
Ceratophyllum demersum
Ranunculus oblongifolius
Ranunculus pusillus
Daubentonia longifolia
Cynosciadium pinnatum
Forestiera acuminata
Limnanthemum aquaticum
Utricularia biflora
Utricularia inflata
Utricularia radiata
Utricularia vulgaris

Its birds are:

Colymbus dominicus brachypterus
Phalacrocorax vigua mexicanus
Anhinga anhinga
Ixobrychus exilis exilis (R)
Botarurus lentiginosus (R)
Nyctanassa violacea
Nycticorax nycticorax naevius
Butorides virescens virescens
Florida caerulea caerulea
Hydranassa tricolor ruficollis
Leucophoyx thula thula
Casmerodius alba egretta
Ardea herodias wardi
Mycteria americana
Guara alba
Plegadis guarauna
Ajaia ajaja
Alix sponsa
Spatula clypeata (R)
Querquedula discors (R)
Anas fulvigula maculosa
Dendrocygna bicolor
Squatarola squatarola cynosurae
Oxyechus vociferus vociferus
Numenius americanus americanus (R)
Limnodromus griseus griseus
Limnodromus griseus scolopaceus
Totanus melanoleucus (R)
Catoptrophorus semipalmatus semipalmatus
Himantopus mexicanus
Larus atricilla megalopterus
Gelichelidon nilotica aranea
Hydroprogne caspia imperator (R)
Thalasseus maximus (R)
Thalasseus sandvicensis acuflvida (R)
Sterna forsteri
Sterna hirundo (R)
Sternula albifrons antillarum
Zenaidura macroura marginella
Streptoceryle alcyon alcyon

Dendrocygna autumnalis
Coragyps ururbu urubu
Cathartes aura septentrionalis
Tachytriorchis albicaudatus sennetti
Buteo swainsoni (R)
Haliaeetus leucocephalus leucocephalus
Accipiter cooperii (R)
Accipiter velox (R)
Circus cyeneus hudsonius (R)
Elanus leucurus majusculus (R)
Elanoides forficatus forficatus (R)
Pandion haliaetus carolinensis (R)
Fulica americana (R)
Gallinula chloropus cachinnans
Porphyrula martinica
Rallus elegans (R)
Rallus longirostris saturatus
Otus asio asio (=*floridanus*) (R)
Otus asio mccallii (R)
Chordeiles Minor chapmani
Chaetura pelagica
Tyrannus tyrannus tyrannus
Muscivora forficata
Corvus brachyrhynchos paulus
Hirundo rustica erythrogastris
Stelgidopteryx serripennis serripennis
Progne subis subis
Geothlypis trichas trichas
Agelaius phoeniceus phoeniceus (=*floridanus*)
Agelaius phoeniceus megapotamus
Megaquiscalus major major
Megaquiscalus major macrourus
Quiscalus quiscala aeneus
Molothrus ater obscurus

Eastern Riparian Association.

This comprises the cypress and other fresh-water swamps, the bayous, the humid river valleys and bottomlands of the eastern third of the State. It is one of the best-marked ecologic division of Texas, and is noted for its heavy deciduous forest, with occasionally thick undergrowth or stretches of wet thickets; but with little or no open land, excepting the broad, sandy, flood-swept beds of some of the rivers. The dense thickets and heavy forests form an ideal retreat for such birds as require seclusion and abundance of shelter. Its most important birds are the forest and humid thicket species of the austroriparian division of the lower austral life zone of the Nearctic Region.

The characteristic plants are as follows:

Polypodium polypodioides
Taxodium distichum
Arundinaria macrosperma
Dendropogon usneoides
Tradescantia virginica
Hymenocallis occidentalis
Smilax bonanox
Smilax cinnamomifolia
Smilax hispida
Smilax laurifolia
Gleditsia triacanthos
Cercis canadensis
Bradleia frutescens
Zanthoxylum clavaherculis
Rhus copalina
Rhus lanceolata
Toxicodendron radicans
Ilex cassine
Ilex decidua
Ilex lucida

Smilax rotundifolia
Leitneria floridana
Populus deltoides
Salix interior
Salix longipes
Salix nigra
Cerothamnus cerifera
Hicoria alba
Hicoria aquatica
Hicoria glabra
Hicoria ovata
Hicoria pecan
Juglans nigra
Alnus rugosa
Betula nigra
Carpinus caroliniana
Ostrya virginiana
Castanea pumila
Quercus alba
Quercus digitata
Quercus lyrata
Quercus macrocarpa
Quercus michauxii
Quercus nigra
Quercus phellos
Quercus texana
Quercus velutina
Quercus virginiana
Celtis mississippiensis
Planera aquatica
Ulmus alata
Ulmus americana
Ulmus fulva
Morus rubra
Toxylon pomiferum
Phoradendron flavescens
Viorna crispa
Magnolia foetida
Magnolia virginiana
Asimina triloba
Persea borbonia
Hamamelis virginiana
Liquidamber styraciflua
Platanus occidentalis
Rubus procumbens
Rubus trivialis
Crataegus aestivalis
Crataegus brachyacantha
Ilex opaca
Ilex vomitoria
Berchemia scandens
Rhamus caroliniana
Rhamus lanceolata
Acer drummondii
Acer negundo
Acer rubrum
Ampelopsis arborea
Ampelopsis cordata
Parthenocissus quinquefolia
Vitis cinerea cancescens
Vtis cordifolia
Vitis rupestris
Vitis vulpina
Tilia americana
Tilia leptophylla
Passiflora incarnata
Jussiaea decurrens
Jussiaea leptocarpa
Jussiaea suffruticosa
Ludwigia glandulosa
Aralia spinosa
Cornus asperifolia
Cornus stricta
Cynoxylon floridum
Nyssa aquatica
Nyssa sylvatica
Azalea canescens
Diospyros virginiana
Mohrdendron carolinum
Mohrodendron dipterum
Styrax platanifolia
Styrax pulverulenta
Gelsemium sempervirens
Fraxinus americana
Fraxinus caroliniana
Callicarpa americana
Bignonia crucigera
Campsis radicans
Catalpa catalpa
Catalpa speciosa
Utricularia cornuta
Utricularia inflata
Utricularia juncea
Utricularia radiata
Cephalanthus occidentalis
Mitchella repens

Crataegus chapmanii
Crataegus marshallii
Crataegus spathulata
Crataegus viridis
Gleditsia aquatica
Viburnum molle
Viburnum nudum
Viburnum rufidulum
Iva angustifolia

Its birds are:

Nyctanassa violacea
Nycticorax nycticorax naevius
Butorides virescens virescens
Florida caerulea caerulea
Hydranassa tricolor ruficollis
Leucophoyx thula thula
Casmerodius alba egretta
Ardea herodias wardi
Mycteria americana
Aix sponsa
Coragys urubu urubu
Cathartes aura septentrionalis
Cerchneis sparveria sparveria
Buteo borealis borealis (R)
Buteo lineatus alleni
Buteo platypterus platypterus
Haliaeetus leucocephalus leucocephalus (R)
Accipiter cooperii (R)
Accipiter velox (R)
Circus cyaneus hudsonius (R)
Ictinia mississippiensis
Elanoides forficatus forficatus (R)
Meleagris gallopavo silvestris
Colinus virginiauns virginianus
Fulica americana (R)
Gallimula chloropus cachinnans (R)
Actitis macularia (R)
Rubicola minor (R)
Sternula albifrons antillarum
Zenaidura macroura marginella
Coccyzus americanus americanus
Colaptes auratus auratus
Centurus carolinus
Melanerpes erythrocephalus erythrocephalus
Phloeotomus pileatus pileatus
Phrenopicus borealis
Dryobates pubescens pubescens
Dryobates villosus audubonii
Myarchus crinitus crinitus
Tyrannus twrannus tyrannus
Mimus polyglottos polyglottos
Dumetella carolinensis (R)
Sialia sialis sialis
Hylocichla mustelina
Polioptila caerulea caerulea
Thryothorus ludovicianus ludovicianus
Sitta pusilla
Sitta carolinensis carolinensis (=*aikeni*)
Bäeolophus bicolor
Cyanocitta cristata cristata (=*florincola*)
Corvus brachyrhynchos paulus
Vireo bellii bellii
Vireo griseus griseus
Lanivireo flavifrons
Vireosylva olivacea
Stelgidopteryx serripennis serripennis.
Progne subis subis
Setophaga ruticilla
Wilsonia citrina
Icteria virens virens
Geothlypis trichas trichas
Oporornis formosus
Seiurus motacilla (R)
Dendroica dominica albilora
Dendroica cerulea
Compsothlypis americana ramalinae
Protomotaria citrea
Helmitheros vermivorus
Limothlypis swainsonii
Mniotilta varia
Agelaius phoeniceus phoeniceus (=*floridanus*)
Agelaius phoeniceus predatorius
Icterus galbula (R)

Campephilus principalis
Streptoceryle alcyon alcyon
Bubo virginianus virginianus
Otus asio asio (=floridanus)
Strix varia alleni
Antrostomus carolinensis
Archilochus colubris
Chaetura pelagica
Horizopus virens
Empidonax virescens
Icterus spurius
Megaquiscalus major major
Quiscalus quiscalus aeneus
Molothrus ater ater
Piranga rubra rubra
Richmondena cardinalis magnirostris
Guiraca caerulea caerulea
Passerina ciris ciris
Passerina cyanea

Eastern Pine Association.

This is also a forest area, and consists of the practically pure stands of pine timber in the eastern third of the State. The dominant trees are *Pinus taeda, Pinus echinata,* and *Pinus palustris;* but in the more open parts of the forest and particularly along the small streams and dry stream beds there is in places a considerable admixture of deciduous trees and shrubs. Its avifauna is a combination of pine inhabitating and other forest species, entirely lacking shore birds and waterfowl. In few areas is the influence of the vegetation on the bird life more evident.

The principal plants are included in the following list:

Pteridium aquilinum
Pteridium caudatum
Pinus echinata
Pinus palustris
Pinus taeda
Anthaenanthia villosa
Elyonurus tripsacoides
Muhlenbergia capillaris
Muhlenbergia expansa
Panicum aciculare
Panicum angustifolium
Panicum arenicoloides
Panicum consanguineum
Tridens ambiguus
Dichromena colorata
Rhynchospora fuscoides
Rhynchospora grayi
Rhynchospora rariflora
Rhynchospora semiplumosa
Scleria ciliata
Scleria gracilis
Scleria trichopoda
Rhus copallina
Rhus glabra
Rhus lanceolata
Toxicodendron radicans
Toxicodendron toxicodendron
Celastrus scandens
Parthenocissus quinquefolia
Vitis cordifolia
Vitis palmata
Hypericum fasciculatum
Helianthemum carolinianum
Viola vittata
Centella repanda
Eryngium integrifolium
Eryngium prostratum
Eryngium synchaetum
Cornus asperifolia
Batodendron arboreum
Vaccinium elliottii
Diospyros virginiana
Fraxinus lanceolata
Amsonia ciliata

Eriocaulon texense
Xyris ambigua
Xyris baldwiniana
Aletris aurea
Smilax glauca
Smilax lanceolata
Hicoria alba
Hicoria ovata
Ostrya virginiana
Castanea pumila
Fagus grandifolia
Quercus alba
Quercus lyrata
Quercus marylandica
Quercus michauxii
Quercus stellata
Quercus texana
Celtis mississippiensis
Clematis drummondii
Magnolia virginiana
Sassafras sassafras
Liquidambar styraciflua
Rubus trivialis
Crataegus aestivalis
Prunus americana
Prunus hortulana
Prunus tarda
Cercis canadensis
Dolicholus minimus
Erythrina herbacea
Meibomia laevigata
Zanthoxylum clavaherculis
Polygala hookeri
Polygala mariana
Acerates floridana
Breweria aquatica
Breweria pickeringii
Phlox detonsa
Afzelia cassioides
Agalinis setacea
Buchnera elongata
Pentstemon pubescens
Bignonia crucigera
Campsis radicans
Pinguicula pumila
Sambucus canadensis
Viburnum rufidulum
Lobelia appendiculata
Aster phyllolepis
Aster purpuratus
Chaptalia semifloscularis
Chondrophora nudata
Chondrophora virgata
Chrysopsis microcephala
Erigeron quercifolius
Eupatorium compositifolium
Eupatorium rotundifolium
Gaillardia lanceolata
Gnaphalium falcatum
Helenium finebriatum
Hymenopappus carolinensis
Oligoneuron nitidum
Rudbeckia alismaefolia
Rudbeckia bicolor
Solidago amplexicaulis
Solidago celtidifolia
Solidago wardi

The birds are:

Coragyus urubu urubu
Cathartes aura septentrionalis
Cerchneis sparveria sparveria
Buteo borealis borealis
Buteo lineatus alleni
Buteo platyterus platyterus (R)
Accipiter cooperii (R)
Ictinia mississippiensis
Meleagris gallopavo silvestris
Colinus virginianus virginianus
Zenaidura macroura marginella
Coccyzus americanus americanus
Sialia sialis sialis
Polioptila caerulea caerulea
Thryothorus ludoviviannus ludovicianus
Sitta pusilla
Sitta carolinensis carolinensis (=*aikeni*)
Penthestes carolinensis carolinensis
Baeolophus bicolor
Cyanocitta cristata cristata (=*florincola*)

Colaptes auratus auratus
Centurus carolinus
Melanerpes erythrocephalus erythrophalus
Phloeotomus pileatus pileatus
Phrenopicus borealis
Dryobates pubescens pubescens
Dryobates villosus villosus (R)
Dryobates villosus audubonii
Bubo virginianus virginianus
Otus asio asio (=*floridanus*)
Strix varia alleni
Antrostomus carolinensis
Chordeiles minor chapmani
Archilochus colubris
Chaetura pelagica
Horizopus virens
Myiarchus crinitus crinitus
Corvus brachyrhynchos brachyrhynchos
Corvus brachyrhynchos paulus
Vireo griseus griseus
Lanivireo flavifrons
Vireosylva olivacea
Setophaga ruticilla
Dendroica pinus pinus
Dendroica dominica albilora
Mniotilta varia
Icterus spurius (R)
Piranga rubra rubra
Richmondena cardinalis magnirostris
Spizella passerina passerina
Peucaea aestivalis illinoensis
Astragalinus tristis tristis (R)

Eastern Oak Association.

This is the area of deciduous woodlands on the uplands in the eastern third of Texas. Portions of it are forest composed almost entirely of post-oak (*Quercus stellata*); others are rich woods of various deciduous trees and bushes, sometimes with an admixture of pine.

The most conspicuous plants are included in the subjoined list:

Usnea barbata
Pinus echinata
Pinus taeda
Bromus purgans
Eragrostis hirsuta
Festuca obtusa
Leptochloa dubia
Muhlenbergia capiltaris
Muhlenbergia diffusa
Panicum barbulatum
Panicum commutatum
Panicum depauperatum
Panicum dichotomum
Panicum flexile
Panicum huachucae silvicola
Panicum lanuginosum
Panicum lindheimeri
Panicum linearifolium
Panicum malacophyllum
Crataegus chapmanii
Crataegus spathulata
Malus soulardi
Padus serotina
Prunus americana
Prunus hortulana
Prunus tarda
Gleditsia triacanthos
Gymnocladus diodica
Cercis canadensis
Meibomia dillenii
Meibomia grandiflora
Meibomia pauciflora
Meibomia viridiflora
Psoralea pedunculata
Xanthoxalis stricta
Zanthoxylum clavaherculis
Acalypha gracilens
Acalypha virginica

Panicum oligosanthes
Panicum ovale
Panicum thurowii
Panicum villosissimum
Panicum virgatum
Panicum werneri
Panicum xalapense
Poa autumnalis
Sphenopholis pallens
Carex digitalis
Carex retroflexa
Carex styloflexa
Carex triceps
Carex wildenovii
Cuthbertia graminea
Tinantia anomala
Juncoides bulbosum
Polygonatum commutatum
Smilax cinnamomiifolia
Smilax glauca
Smilax pseudochina
Smilax rotundifolia
Sisyrinchium pruinosum
Sisyrinchium sagittiferum
Achroanthes monophylla
Blephariglottis ciliaris
Corallorphiza wisteriana
Hexalectris aphylla
Ibidium vernale
Cerothamnus cerifera
Hicoria alba
Hicoria myristicaeformis
Hicoria ovata
Juglans nigra
Ostrya virginiana
Castanea pumila
Fagus grandifolia
Quercus alba
Quercus brevifolia
Quercus digitata
Quercus durandi
Quercus lyrata
Quercus macrocarpa
Quercus marylandica
Quercus muhlenbergii
Quercus phellos
Quercus prinoides
Quercus rubra
Phyllanthus carolinensis
Stillingia sylvatica
Rhus copallina
Rhus glabra
Schmaltzia trilobata
Toxicodendron radicans
Ilex decidua
Celastrus scandens
Aesculus pavia
Ampelopsis cordata
Parthenocissus quinquefolia
Vitis cordifolia
Vitis linsecomii
Vitis palmata
Tilia americana
Viola missouriensis
Viola rafinesquii
Viola walteri
Chaerophyllum tainturieri
Dringa canadensis
Eryngium ludovicianum
Sanicula canadensis
Cornus asperifolia
Cynoxylon floridum
Nyssa sylvatica
Vaccinium elliottii
Diospyros virginiana
Mohrodendron carolinum
Fraxinus americana
Spigelia marylandica
Obolaria virginica
Apocynum androsaemifolium
Phlox pilosa
Koellia albescens
Salvia lyrata
Scutellaria cardiophylla
Scutellaria integrifolia
Scutellaria pilosa
Agalinis gattingeri
Dasystoma gardiflora
Pedicularis canadensis
Ruellia pedunculata
Campsis radicans
Plantago rugelii
Galium circaezans
Galium pilosum
Galium triflorum
Galium uniflorum

Quercus stellata
Quercus velutina
Celtis mississipiensis
Ulmus americana
Morus rubra
Toxylon pomiferum
Phoradendron flavescens
Tiniaria cristata
Tovara virginiana
Chenopodium boscianum
Rivina humilis
Claytonia virginica
Silene stellata
Clematis drummondii
Isopyrum biternatum
Ranunculus fascicularis
Magnolia virginiana
Cebatha carolina
Podophyllum peltatum
Sassafras sassafras
Liquidambar styraciflua
Rosa engelmannii
Mitchella repens
Sambucus canadensis
Viburnum rufidulum
Viburnum ruficulum
Cyclanthera dissecta
Hieracium longipilum
Lactuca graminifolia
Chrysopsis nuttallii
Cirsium flaccidum
Cirsum muticum
Elephantopus carolinianus
Eupatorium compositifolium
Eupatorium incarnatum
Rudbeckia bicolor
Solidago amplexicaulis
Solidago bootii
Solidago caesia
Solidago celtidifolia
Solidago rugosa
Solidago ulmifolia
Solidago wardi
Verbesina helianthoides

The birds of this area are as follows:

Coragyps urubu urubu
Cathartes aura septentrionalis
Cerchneis sparveria sparveria
Polyborus cheriway auduboni
Buteo borealis borealis
Buteo lineatus alleni
Buteo platypterus platypterus (F)
Accipiter cooperii (R)
Accipiter velox (R)
Ictinia mississippiensis
Meleagris gallopavo silvestris
Colinus virginianus virginianus
Zenaidura macroura marginella
Geococcyx californianus (R)
Coccyzus americanus americanus
Colaptes auratus auratus
Melanerpes erythrocephalus erythrocephalus
Phloeotomus pileatus pileatus
Phrenopicus borealis
Dryobates pubescens pubescens
Dryobates villosus villosus (R)
Dryobates villosus audubonii
Bubo virginianus virginianus
Hylocichla mustelina
Polioptila caerulea caerulea
Thryomanes bewickii cryptus
Thryothorus ludovicianus ludovicianus
Sitta pusilla
Sitta carolinensis carolinensis (=*aikeni*)
Penthestes carolinensis carolinensis
Baelophus bicolor
Cyanocitta cristata cristata (=*florincola*)
Corvus brachyrhynchos brachyrhynchos
Corvus brachrhynchos paulus
Vireo bellii bellii
Vireo griseus griseus
Lanivireo flavifrons
Vireosylva olivacea
Setophaga ruticilla
Icteria virens virens
Dendroica pinus pinus
Dendroica dominica albilora

Otus asio asio (=*floridanus*)
Strix varia alleni
Antrostomus carolinensis
Chordeiles minor chapmani
Chordeiles minor howelli
Archilochus colubris
Chaetura pelagica
Horizopus virens
Empidonax traillii brewsteri (R)
Empidonax minimus (R)
Myiarchus crinitus crinitus
Tyrannus tyrannus tyrannus
Mimus polyglottos polyglottos (R)
Sialia sialis sialis
Compsothlypis americana ramalinae
Mniotilta varia
Icterus spurius
Piranga rubra rubra
Richmondena cardinalis magnirostris
Passerina ciris ciris
Passerina ciris pallidior
Passerina cyanea
Spizella pusilla pusilla
Peucaea aestivalis illinoensis
Chondestes gramacus strigatus
Astragalinus tristis tristis (R)

Eastern Brush Association.

The various kinds of brushy tracts and abandoned fields grown up to bushes and high weeds, on the uplands of the eastern third of the State, constitute this type of country. The brushy areas are clothed with a shrubby vegetation mixed with annuals and perennials, and more or less sparingly intermingled with trees that thrive in the open. The old fields are in most cases thickly covered with high herbaceous vegetation in places somewhat mixed with bushes and scattered trees. Comformably to the vegetation the bird-life shows an absence of strictly forest types, and comprises chiefly such species as are inhabitants of thickets or more open country.

The plants most conspicuous in this area are included in the list below:

Aristida dichotoma
Aristida lanosa
Bromus unioloides
Capriola dactylon
Cenchrus carolinianus
Cenchrus echinatus
Chaetochloa gracilis
Chaetochla italica
Echinochloa colonum
Echinochloa crusgalli
Eleusine indica
Eragrostis hirsuta
Eragrostis pilosa
Festuca obtusa
Geum vernum
Rosa cherokeensis
Rubus procumbens
Rubus trivialis
Crataegus chapmanii
Crataegus marhsallii
Crataegus spathulata
Malus soulardi
Prunus americana
Prumus hortulana
Prunus tarda
Morongia angustata
Morongia uncinata
Apios apios

Hordeum nodosum
Hordeum pusillum
Muhlenbergia diffusa
Panicum brachyanthum
Panicum capillare
Panicum commutatum
Panicum dichotomiflorum
Panicum fasciculatum reticulatum
Panicum flexile
Panicum huachucae silvicola
Panicum lindheimeri
Panicum sphaerocarpon
Panicum texanum
Panicum virgatum
Rytilix granularis
Syntherisma sanguinalis
Syntherisma villosa
Carex digitalis
Carex retroflexa
Carex styloflexa
Carex willdenovii
Scleria triglomerata
Juncoides bulbosum
Erythronium albidum
Quamasis hyacinthina
Smilax bonanox
Smilax cinnamomifolia
Smilax glauca
Smilax pseudochina
Smilax rotundifolia
Dioscorea villosa
Hypoxis hirsuta
Cerothamnus cerifera
Ostrya virginiana
Castanea pumila
Quercus marylandica
Urtica chamaedryoides
Morus alba
Morus nigra
Toxylon pomiferum
Rumex obtusifolius
Tiniaria cristata
Tovara virginiana
Chenopodium album
Chenopodium berlandieri
Chenopodium boscianium
Chenopodium botrys
Amaranthus blitoides
Clitoria mariana
Falcata pitcheri
Meibomia bracteosa
Meibomia paniculata
Meibomia sessilifolia
Vigna sinensis
Xanthoxalis stricta
Zantoxylum clavaherculis
Acalypha gracilens
Acalypha virginica
Rhus copallina
Rhus glabra
Rhus lanceolata
Schmaltzia trilobata
Toxicodendron radicans
Toxicodendron toxicodendron
Ilex decidua
Celastrus scandens
Cardiospermum halicacabum
Cardiospermum microcarpum
Parthenocissus quinquefolia
Vitis palmata
Modiola caroliniana
Viola walteri
Cornus asperifolia
Cynoxylon floridum
Diospyros virginiana
Obolaria virginica
Apocynum androsaemifolium
Apocynum cannabinum
Asclepias variegata
Ipomoea purpurea
Blephilia hirsuta
Koellia flexuosa
Mentha rotundifolia
Salvia lyrata
Scutellaria integrifolia
Scutellaria pilosa
Trichostema dichotomum
Datura stramonium
Datura tatula
Physalis mollis
Solanum nigrum
Afzelia macrophylla
Pedicularis canadensis
Veronica serpyllifolia
Campsis radicans
Plantago rugelii

Amaranthus graecizans
Amaranthus hybridus
Amaranthus retroflexus
Phytolacca americana
Rivina humilis
Mollugo verticillata
Portulaca oleracea
Arenaria lanuginosa
Silene antirrhina
Clematis drummondii
Viorna coccinea
Cebatha carolina
Sassafras sassafras
Coronopus coronopus
Coronopus didymus
Lepidium densiflorum
Lepidium virginicum
Liquidambar styraciflua
Galium circaezans
Galium triflorum
Sambucus canadensis
Viburnum rufidulum
Cucumis anguria
Cyclanthera dissecta
Ibervillea tripartita
Melothria chlorocarpa
Sicyos angulata
Aster phyllolepis
Aster purpuratus
Aster texanus
Cirsium altissimum
Cirsium muticum
Parthenium hysterophorus
Polymnia uvedalia
Rudbeckia triloba
Solidago caesia

The birds found here are:

Coragyps urubu urubu
Cathartes aura septentrionalis
Cerchneis sparveria sparveria
Polyborus cheriway auduboni (R)
Buteo borealis borealis
Buteo platypterus platypterus (R)
Accipiter cooperii (R)
Accipiter velox (R)
Ictinia mississippiensis (R)
Meleagris gallopavo silvestris (R)
Colinus virginianus virginianus
Zenaidura macoura marginella
Geococcyx californianus (R)
Coccyzus americanus americanus
Colaptes auratus auratus
Melanerpes erythrocephalus erythrocephalus
Dryobates pubescens pubescens
Bubo virginianus virginianus (R)
Otus asio asio (=*floridanus*) (R)
Antrostomus carolinensis
Chordeiles minor chapmani
Archilochus colubris
Chaetura pelagica
Horizopus virens
Empidonax traillii brewsteri (R)
Empidonax minimus (R)
Myarchus crinitus crinitus
Sitta carolinensis carolinensis (=*aikeni*)
Penthestes carolinensis carolinensis
Baeolophus bicolor
Cyanocitta cristata cristata (=*florincola*)
Corvus brachyrhynchos brachyrhynchos
Corvus brachyrhynchos paulus
Vireo bellii bellii
Vireo griseus griseus
Lanivireo flavifrons (R)
Hirundo rustica erythrogastris
Progne subis subis
Icteria virens virens
Geothlypis trichas trichas
Dendroica discolor (R)
Dendroica aestiva aestiva (R)
Icterus galbula (R)
Icterus spurius
Quiscalus quiscula aeneus
Molothrus ater ater
Piranga rubra rubra
Richmondena cardinalis magnirostris
Guiraca caerulea caerulea
Passerina ciris ciris

Tyrannus tyrannus tyrannus
Muscivora forficata (R)
Mimus polyglottos polyglottos
Dumetella carolinensis (R)
Sialia sialis sialis
Polioptila caerulea careulea
Thryomanes bewickii cryptus
Thryothorus ludovicianus ludovicianus
Passerina ciris pallidior
Passerina cyanea
Spizella pusilla pusilla
Spizella passerina passerina
Peucaea aestivalis illinoensis
Chondestes grammacus strigatus
Spiza americana
Passer domesticus domesticus
Astraglinus tristis tristis (R)

Eastern Clearing Association.

The small stretches of open country and the various clearings not under actual cultivation on the eastern Texas uplands constitute this type of country. It is usually free from brush, though it has occasional bushes, thickets, and trees, particularly along fencerows; and ordinarily a more or less grassy covering. In the more recent clearings there are dead trees still standing. Its avifauna is therefore a combination of thicket-loving species and those that live in the open.

Typical of its vegetation are the following:

Agrostis elliottiana
Andropogon scoparius
Andropogon ternatus
Andropogon virginicus
Aristida dichotoma
Aristida gracilis
Aristida intermedia
Aristida oligantha
Aristida purpurascens
Aristida purpurea
Axonopus compressus
Axonopus furcatus
Capriola dactylon
Cenchrus carolinianus
Cenchrus echinatus
Cenchrus incertus
Chaetochloa geniculata
Chaetochloa gracilis
Chaetochloa italica
Chloris verticillata
Echinochloa colonum
Echinochloa crusgalli
Eleusine indica
Eragrostis capillaris
Sorghastrum nutans
Sphenopholis filiformis
Sphenopholis interrupta
Sphenopholis obtusata pubescens
Pphenopholis pallens longiflora
Sporobolus asper
Sporobolus asperifolius
Sporobolus canovirens
Sporobolus cryptandrus
Sporobolus drummondii
Sporobolus gracilis
Syntherisma sanguinalis
Syntherisma villosa
Tridens flavus
Uniola laxa
Yucca tenuistyla
Smilax glauca
Smilax pseudochina
Smilax rotundifolia
Cerothamnus cerifera
Quercus marylandica
Quercus stellata
Quercus texana
Quercus velutina

Eragrostis hirsuta
Eragrostis pectinacea
Eragrostis pilosa
Eragrostis secundiflora
Eragrostis trichodes
Festuca octoflora
Festuca sciurea
Gymnopogon ambiguus
Heteropogon melanocarpus
Holcus halapensis furcatus
Hordeum nodosum
Hordeum pusillum
Manisuris cylindrica
Panicum anceps
Panicum brachyanthum
Panicum capillare
Panicum dichotomiflorum
Panicum fasciculatum
Panicum flexile
Panicum geminatum
Panicum hians
Panicum huachucae silvicola
Panicum lindheimeri
Panicum ovinum
Panicum polyanthes
Panicum praecocius
Panicum reptans
Panicum sphaerocarpon
Panicum texanum
Panicum virgatum
Paspalum angustifolium
Paspalum larranagai
Paspalum plicatulum
Paspalum pubiflorum
Rytilix granularis
Schedonnardus paniculatus
Ulmus americana
Morus rubra
Toxylon pomiferum
Sassafras sassafras
Lepidium densiflorum
Lepidium medium
Lepidium virginicum
Rubus procumbens
Rubus trivialis
Crataegus chapmanii
Crataegus marshallii
Crataegus spathulata
Malus soulardi
Padus serotina
Prunus americana
Gledistsia triacanthos
Morongia angustata
Morongia uncinata
Daubentonia longifolia (R)
Zanthoxylum clavaherculis
Rhus copallina
Rhus glabra
Toxicodendron radicans
Celastrus scandens
Parthenocissus quinquefolia
Passiflora incarnata
Mamillaria missouriensis
Opuntia humifusa
Opuntia macrorhiza
Cornus asperifolia
Cynoxylon floridum
Diospyros virginiana
Convolvulus repens
Campsis radicans
Sambucus canadensis

The birds to be found in this association are:

Coragyps urubu urubu
Cathartes aura septentrionalis
Cerchneis sparveria sparveria
Polyborus cheriway auduboni
Buteo borealis borealis
Buteo platypterus platypterus (R)
Accipiter cooperii (R)
Accipiter velox (R)
Circus cyaneus hudsonius (R)
Ictinia mississippiensis
Muscivora forficata (R)
Mimus polyglottos polyglottos
Sialia sialis sialis
Cyanocitta cristata cristata (=*florincola*)
Corvus brachyrhynchos brachyrhynchos
Corvus brachyrhynchos paulus
Lanivireo flavifrons
Vireosylva gilva gilva (R)

Elanoides forficatus forficatus (R)
Meleagris gallopavo silvestris (R)
Tympanuchus americanus attwateri
Colinus virginianus virginianus
Oxyechus vociferus vociferus
Bartramia longicauda (R)
Zenaidura macoura marginella
Coccyzus americanus americanus
Colaptes auratus auratus
Centurus carolinus (R)
Melanerpes erythrocephalus erythrocephalus
Dryobates pubescens pubescens
Dryobates villosus audubonii
Otus asio asio (=*floridanus*)
Tydo alba pratincola (R)
Chordeiles minor chapmani
Chordeiles minor howelli
Archilochus colubris
Chaetura pelagica
Horizopus virens
Tyrannus tyrannus tyrannus
Hirundo rustica erythrogastris
Stelgidopteryx serripennis serripennis
Progne subis subis
Sturnella magna mangna
Sturnella magna argutula
Icterus galbula (R)
Icterus spurius
Quiscalus quiscula aeneus
Molothrus ater ater
Piranga rubra rubra
Guiraca caerulea caerulea
Passerina ciris ciris
Passerine ciris pallidior
Passerina cyanea
Spizella pusilla pusilla
Spizella passerina passerina
Peucaea aestivalis illinoensis
Ammodramus savannarum bimaculatus
Chondestes grammacus strigatus
Spiza americana
Passer domesticus domesticus
Astragalinus tristis tristis (R)

Eastern Agrarian Association.

This comprises the grain and other cultivated fields, the cultivated meadows, the gardens, orchards, and dooryards of the eastern Texas uplands. In the fields and gardens the various farm crops are the predominant vegetation, but there are some bushes and trees, with herbaceous vegetation, about the fencerows and similar places. Grasses and annuals cover the meadows; various fruit trees fill the orchards; while shade trees and shrubs surround the houses and ornament the dooryards. This combination of vegetation proves exceedingly attractive to birds that live more or less in the open; though most of the distinctively thicket and forest species, together with of course practically all the water and shore birds, are absent.

The character of the vegetation is shown by the following list of plants:

Pinus echinata
Pinus palustris
Pinus taeda
Quercus texana
Quercus relutina
Ulmus americana

Juniperus virginiana
Andropogon furcatus
Andropogon glomeratus
Andropogon ternatus
Andropogon virginicus
Anthoxanthum odoratum
Bromus unioloides
Capriola dactylon
Cenchrus carolinianus
Cenchrus echinatus
Cenchrus incertus
Chaetochloa italica
Chaetochloa lutescens
Chaetochloa verticillata
Chaetochloa viridis
Dactyloctenium aegyptium
Echinochloa colonum
Echinochloa crusgalli
Eleusine indica
Eragrostis hirsuta
Eragrostis pilosa
Heteropogon melanocarpus
Holcus halapensis
Hordeum nodosum
Manisuris cylindrica
Panicum agrostoides
Panicum anceps
Panicum brachyanthum
Panicum capillare
Panicum dichotomiflorum
Panicum fasciculatum reticulatum
Panicum flexile
Panicum geminatum
Panicum reptans
Panicum sphaerocarpon
Panicum texanum
Panicum virgatum
Paspalum angustifolium
Paspalum geminum
Paspalum larranagai
Paspalum plicatulum
Paspalum pubiflorum
Phleum pratense
Rytilix granularis
Sorghastrum nutans
Sphenopholis interrupta
Syntherisma sanguinalis
Ulmus crassifolia
Morus alba
Morus nigra
Morus rubra
Toxylon pomiferum
Chenopodium album
Amaranthus retroflorus
Mollugo verticillata
Magnolia foetida
Sassafras sassafras
Lepidium densiflorum
Lepidium medium
Lepidium virginicum
Rubus procumbens
Rubus trivialis
Crataegus chapmanii
Crataegus marshallii
Crataegus spathulata
Malus soulardi
Padus serotina
Prunus americana
Gleditsia triacanthos
Morongia angustata
Morongia uncinata
Cercis canadensis
Lathyrus pusillus
Medicago maculata
Trifolium carolinianum
Trifolium dubium
Trifolium pratense
Trifolium reflexum
Vicia lidoviciana
Xanthovalis langloisii
Melia azedarach
Croton texensis
Rhus copallina
Rhus glabra
Toxicodendron radicans
Celastrus scandens
Acer rubrum
Parthenicissus quinquefolia
Passiflora incarnata
Opuntia macrorhiza
Raimannia laciniata
Cynoxylon floridum
Diospyros virginiana
Convolvulus repens

(Continued in next issue.)

The American Midland Naturalist

PUBLISHED BI-MONTHLY BY THE UNIVERSITY
OF NOTRE DAME, NOTRE DAME, INDIANA

Vol. IX. NOVEMBER, 1925. No. 12.

THE RELATIONS OF VEGETATION TO BIRD LIFE IN TEXAS.

HARRY C. OBERHOLSER.

(Conclusion.)

Toxicodendron radicans
Celastrus scandens
Acer rubrum
Parthenocissus quinquefolia
Passiflora incarnata
Opuntia macrorhiza
Raimannia laciniata
Cynoxylon floridum
Diospyros virginiana
Convolvulus repens
Datura stramonium
Datura tatula
Solanum elaeagnifolium
Campsis radicans
Sambucus canadensis
Sonchus asper
Sonchus clearaceus
Senecio ampullaceus
Senecio vulgaris

Cultivated crops:

Barley
Bermuda grass
Broom-corn
Corn
Hungarian grass
Johnson grass
Kaffir corn
Millet
Oats
Rye
Sorghum
Sugar-cane
Wheat
Onion
Fig
Beet
Spinach
Sugar beet
Cabbage
Mustard
Radish
Currant
Gooseberry
Blackberry
Raspberry
Strawberry
Apple
Pea
Peanut
Flax
Grape
Cotton
Okra
Celery
Cape jessamine
Egg plant
Irish potato
Pepper
Sweet potato
Tobacco

Pear
Apricot
Peach
Plum
Alfalfa
Bean
Cowpea
Tomato
Cantaloupe
Cucumber
Pumpkin
Squash
Watermelon
Lettuce

The birds found here are:

Coragyps urubu urubu
Cathartes aura septentrionalis
Cerchneis sparveria sparveria
Polyborus cheriway auduboni (R)
Buteo borealis borealis (R)
Accipiter cooperii (R)
Accipiter velox (R)
Circus cyaneus hudsonius (R)
Meleagris gallopavo silvestris (R)
Tympanuchus americanus attwateri (R)
Colinus virginianus virginianus
Oxyechus vociferus vociferus
Bartramia longicauda (R)
Zenaidura macroura marginella
Coccyzus americanus americanus
Colaptes auratus auratus
Melanerpes erythrocephalus erythrocephalus
Dryobates pubescens pubescens
Dryobates villosus audubonii (R)
Otus asio asio (=*floridanus*)
Strix varia alleni
Tyto alba pratincola (R)
Chordeiles minor chapmani
Chordeiles minor howelli
Archilochus colubris
Chaetura pelagica
Horizopus virens
Myiarchus crinitus crinitus
Tyrannus tyrannus tyrannus
Muscivora forficata
Mimus polyglottos polyglottos
Dumetella carolinensis (R)
Sialia sialis sialis
Polioptila caerulea caerulea
Thryomanes bewickii cryptus
Thryothorus ludovicianus ludovicianus
Penthestes carolinensis carolinensis
Cyanocitta cristata cristata (=*florincola*)
Corvus brachyrhynchos brachyrhynchos
Corvus brachyrhynchos paulus
Vireo bellii bellii
Lanivireo flavifrons
Vireosylva gilva gilva (R)
Vireosylva olivacea
Hirundo rustica erythrogastris
Stelgidopteryx serripennis serripennis
Progne subis subis
Geothlypis trichas trichas
Sturnella magna magna
Sturnella magna argutula
Sturnella neglecta neglecta (R)
Icterus galbula (R)
Icterus spurius
Quiscalus quiscula aeneus
Molothrus ater ater
Piranga rubra rubra (R)
Richmondena cardinalis magnirostris
Guiraca caerulea caerulea
Passerina ciris ciris
Passerina ciris pallidior
Passerina cyanea
Spizella pusilla pusilla
Spizella passerina passerina
Ammodramus savannarum bimaculatus
Chondestes grammacus strigatus
Spiza americana
Passer domesticus domesticus
Astragalinus tristis tristis (R)

Inland Prairie Association.

This includes the open grassy prairies of the eastern and east central interior portions of the State, including those between the Upper and Lower Cross Timbers. On these prairies the principal vegetation, aside from the grass which covers them, is a great variety of low flowering herbaceous or suffruticose plants. Occasional bushes and here and there a live-oak or other low tree form the only woody vegetation. The avifauna is consequently distinctly campestrian and lacks the purely thicket and forest elements.

The important plants are included in the following list:

Agrostis alba
Agrostis elliottiana
Andropogon chrysocomus
Andropogon glomeratus
Andropogon scoparius
Andropogon virginicus
Aristida tuberculosa
Bouteloua gracilis
Bouteloua hirsuta
Chaetochloa geniculata
Chaetochloa gracilis
Chaetochloa italica
Chaetochloa lutescens
Chaetochloa viridis
Eragrostis capillaris
Eragrostis curtipedicellata
Eragrostis lugens
Eragrostis pectinacea
Eriochloa punctata
Festuca sciurea
Holcus halapensis
Hordeum jubatum
Koeleria cristata
Limnodea arkansana
Melica porteri
Muhlenbergia capillaris
Panicum anceps
Panicum brachyanthum
Panicum capillare
Panicum dichotomiflorum
Panicum fasciculatum reticulatum
Panicum filipes
Panicum flexile
Panicum geminatum
Panicum helleri
Panicum lindheimeri
Panicum ovinum
Panicum praecocius
Panicum ravenelii
Panicum reverchoni
Panicum scribnerianum
Panicum sphaerocarpon
Panicum texanum
Panicum thurowii
Panicum virgatum
Poa arachnifera
Poa glabrescens
Sphenopholis hallii
Sphenopholis interupta
Sphenopholis pallens
Sporobolus argutus
Tridens strictus
Sisyrinchium amoenum
Sorghastrum nutans
Sisyrinchium brayi
Sisyrinchium canbyi
Sisyrinchium flaccidum
Sisyrinchium furcatum
Sisyrinchium langloisii
Sisyrinchium minus
Sisyrinchium pruinosum
Sisyrinchium texanum
Sisyrinchium varians
Cerothamnus cerifera
Quercus virginiana
Ranunculus macranthus
Argemone alba
Argemone delicatula

Argemone hispida
Argemone platyceras
Euklisia hyacinthoides
Lepidium austrinum
Lesquerella auriculata
Lesquerella pallida
Lesquerella polyantha
Lesquerella sessilis
Streptanthus maculatus
Prunus glandulosa
Prunus minutiflora
Morongia uncinata
Parosela aurea
Parosela dalea
Parosela enneandra
Petalostemon candidus
Petulostemon decumbens
Petalostemon emarginatus
Petalostemon multiflorus
Petalostemon purpureus
Vicia texana
Chamaesyce malaca
Chamaesyce nuttallii
Ditaxis humilis
Cratiola pusilla
Otophylla densiflora
Pentstemon cobaea
Pentstemon helleri
Pentstemon murrayanus
Diapedium attenuatum
Galium virgatum
Houstonia angustifolia
Cymbia occidentalis
Lactuca ludoviciana
Sitilias grandiflora
Ambrosia bidentata
Aster azureus
Scutellaria cardiophylla
Scutellaria drummondii
Scutellaria resinosa
Physalis pumila
Agalinis heterophylla
Agalinis strictiflora
Conobea multifida
Opuntia macrorhiza
Mentzelia oligosperma
Galpinsia hartwegii
Galpinsia interior
Gaura villosa
Hartmannia speciosa
Cogswellia daucifolia
Eurytaenia texana
Phellopterus macrorhizus
Spermolepis divaricatus
Trepocarpus aethusae
Sabbatia campestris
Vincetoxicum biflorum
Vincetoxicum cynanchoides
Convolvulus hermannioides
Convolvulvus incanus
Nemophila phacelioides
Phacelia glabra
Verbena bracteosa
Verbena canadensis
Verbena drummondii
Hedeoma acinoides
Monarda clinopodioides
Monarda dispersa
Monarda lasiodonta
Monarda scabra
Monarda stanfieldi
Monarda tenuiaristata
Aster drummondii
Aster exiguus
Aster hirtellus
Aster oblongifolius
Aster poaceus
Aster trigonicus
Centaurea americana
Echinacea angustifolia
Gaillardia amblyodon
Gaillardia chrysantha
Gaillardia fastigiata
Gaillardia lanceolata
Gaillardia pulchella
Gaillardia suavis
Gaillardia trinervata
Grindelia grandiflora
Grindelia inuloides
Grindelia lanceolata
Gutierrezia sphaerocarpa
Gutierrezia texana
Helianthus grosseserratus
Helianthus orgyalis
Helianthus scaberrimus
Hymenopappus corymbosus

Hymenopappus tenuifolius
Hymenopappus sulphureus
Laciniaria langloisii
Ratibida pinnata
Ratibida tagetes
Rudbeckia alismaefolia
Rudbeckia grandiflora
Rudbeckia subtomentosa
Senecio ampullaceus
Senecio fremontii
Silphium asperrimum
Silphium gracile
Silphium integrifolium
Silphium laciniatum
Silphium speciosum
Verbesina helianthoides
Vernonia baldwinii
Vernonia drummondii
Vernonia fasciculata
Vernonia interior.

The birds living here are as follows:

Coragyps ururbu urubu
Cathartes aura septentrionalis
Cerchneis sparveria sparveria
Polyborus cheriway auduboni
Buteo borealis borealis
Accipiter cooperii (R)
Accipiter velox (R)
Circus cyaneus hudsonius (R)
Tympanuchus americanus attwateri
Colinus virginianus virginianus
Oxyechus vociferus vociferus
Zenaidura macroura marginella
Speotyto cunicularia hypugaea
Tyto alba pratincola
Chordeiles minor chapmani
Chordeiles minor howelli
Archilochus colubris
Chaetura pelagica
Tyrannus tyrannus tyrannus
Muscivora forficata
Mimus polyglottos polyglottos
Mimus polyglottos leucopterus
Sialia sialis sialis
Corvus brachyrhynchos brachyrhynchos
Corvus brachyrhynchos paulus
Hirundo rustica erythrogastris
Stelgidopteryx serripennis serripennis
Progne subis subis
Geothlypis trichas trichas
Sturnella magna magna
Sturnella magna argutula
Sturnella neglecta neglecta
Agelaius phoeniceus predatorius
Icterus spurius
Quiscalus quiscula aeneus
Molothrus ater ater
Spizella pusilla pusilla
Chondestes grammacus strigatus
Spiza americana

Great Plains Upland Association.

This area, in northwestern Texas, includes the dry, level or rolling stretches of the Great Plains, exclusive of the vicinity of streams, lakes, and ponds. Its characteristic vegetation, in addition to the grass which more or less closely covers the ground, consists of numerous herbaceous flowering plants, scattered bushes and low cactuses, and stretches of "shin oak" (*Quercus gambelii*) and dwarf brush (*Artemisia filifolia*). The birds are those of grassy areas and other open places, but are as a whole of more western type than those on the eastern Texas prairies.

The important plants are:

Ephedra antisyphilitica
Agropyron smithii
Andropogon scoparius
Aristida fendleriana
Aristida havardii
Bouteloua curtipendula
Bouteloua gracilis
Bouteloua hirsuta
Cenchrus carolinianus
Eragrostis cilianensis
Eragrostis secundiflora
Festuca octoflora
Hilaria jamesii
Hordeum jubatum
Muhlenbergia pungens
Munroa squarrosa
Oryzopsis micrantha
Panicum hallii
Panicum obtusum
Panicum reverchonii
Panicum virgatum
Poa bigelovii
Schedonnardus paniculatus
Sporobolus auriculatus
Sporobolus cryptandrus
Sporobolus flexuosus
Sporobolus wrightii
Tridens albescens
Yucca glauca
Yucca stricta
Quercus gambelii
Persicaria persicarioides
Polygonum aviculare
Polygonum camporum
Polygonum erectum
Polygonum ramosissimum
Tiniaria convolvulus
Blitum capitatum
Chenopodium album
Paronychia dichotoma
Paronychia jamesii
Argemone platyceras
Acuan illinoensis
Mimosa biuncifera
Mimosa borealis
Morongia uncinata
Prosopis glandulosa
Hoffmannseggia jamesii
Amorpha canescens
Astragalus caryocarpus
Astragalus mollissimus
Parosela enneandra
Parosela formosa
Petalostemon purpureus
Psoralea digitata
Psoralea linearifolia
Linum rigidum
Polygala alba
Chamaesyce albomarginata
Chamaesyce fendleri
Chamaesyce lata
Chamaesyce nuttallii
Chamaesyce pilulifera
Dichrophyllum marginatum
Schmaltzia trilobata
Glossopetalon spinescens
Zizyphus lycioides
Callirrhoe pedata
Echinocactus texensis
Echinocereus caespitosus
Echinocereus viridiflorus
Mamillaria missouriensis
Opuntia davisi
Opuntia leptocaulis
Opuntia macrorhiza
Nuttallia nuda
Anogra albicaulis
Anogra coronopifolia
Galpinsia hartwegii
Galpinsia lavandulaefolia
Galpinsia tubicula
Hartmannia speciosa
Meriolix intermedia
Oenothera biennis
Oenothera jamesii
Raimannia heterophylla
Asclepias latifolia
Asclepias tuberosa
Vincetoxicum productum
Convolvulus incanus
Evolvulus argenteus
Ipomoea leptophylla

Ipomoea longifolia
Phlox roemeriana
Verbena bipinnatifida
Verbena hastata
Verbena officinalis
Verbena stricta
Verbena xutha
Androcera rostrata
Datura stramonium
Cucurbita foetidissima
Achillea millefolium
Artemisia filifolia
Centaurea americana
Cirsium helleri
Cirsium megacephalum
Cirsium ochrocentrum
Gaillardia pulchella
Gutierrezia sarothrae
Helianthus annuus
Helianthus grosseserratus
Helianthus occidentalis
Helianthus orgyalis
Helianthus petiolaris
Helianthus rigidus
Laciniaria punctata
Ratibida columnifera
Rudbeckia hirta
Rudbeckia subtomentosa
Sideranthus spinulosus
Silphium laciniatum
Silphium speciosum
Solidago sparsiflora
Vernonia fasciculata
Vernonia interior

The birds inhabiting this association are:

Coragyps urubu urubu
Cathartes aura septentrionalis
Cerchneis sparveria sparveria (R)
Planofalco mexicanus * (R)
Buteo borealis borealis
Buteo swainsoni
Buteo regalis † (R)
Aquila chrysaetos canadensis (R)
Accipiter cooperii (R)
Accipiter velox (R)
Circus cyaneus hudsonius (R)
Tympanuchus americanus attwateri (R)
Tympanuchus pallidicinctus
Callipepla squamata pallida
Colinus virginianus virginianus
Oxyechus vociferus vociferus
Podasocys montanus
Numenius americanus americanus
Zenaidura macroura marginella
Speotyto cunicularia hypugaea
Tyto alba pratincola (R)
Chordeiles minor howelli
Tyrannus tyrannus tyrannus
Muscivora forficata
Otocoris alpestris leucolaema
Otocoris alpestris enthymia
Mimus polyglottos leucopterus
Sialia sialis sialis
Salpinctes obsoletus obsoletus
Troglodytes aedon parkmanii (R)
Corvus brachyrhynchos brachyrhynchos
Corvus cryptoleucus
Corvus corax sinuatus
Lanius ludovicianus excubitorides
Hirundo rustica erythrogastris
Stelgidopteryx serripennis serripennis (R)
Petrochelidon albifrons albifrons
Progne subis subis
Sturnella magna magna
Sturnella neglecta neglecta
Xanthocephalus xanthocephalus
Euphagus cyanocephalus
Quiscalus quiscula aeneus
Molothrus ater ater
Nemospiza henslowii henslowii (R)

---

* *Planofalco*, gen. nov.; type, and only species, *Falco mexicanus* Schlegel.

† =*Archibuteo ferrugineus.*

Ammodramus savannarum bimaculatus
Pooecetes gramineus confinis
Chondestes grammacus strigatus
Spiza americana
Calamospiza melanocorys
Passer domesticus domesticus
Carpodacus mexicanus frontalis (R)
Astragalinus tristis tristis (R)

Great Plains Riparian Association.

This comprises the stream valleys of the Great Plains region. Some of these are deep canyons, but most of them are only shallow valleys. Their typical vegetation is a fringe more or less sparse and intermittent, of trees and bushes, with a quota of herbaceous plants. The birds particularly attracted to these valleys are bush- or tree-dwelling species, together with, of course, those that are of genral distribution. The resultant combination is a fauna of considerably greater richness than that of the open plains.

The plants of this association are, in most important part, as follows:

Juniperus sabinoides
Typha latifolia
Carex stipata
Yucca glauca
Yucca stricta
Smilax glauca
Smilax hispida
Smilax rotundifolia
Populus deltoides
Salix nigra
Hicoria pecan
Juglans nigra
Juglans rupestris
Quercus gambelii
Quercus virginiana (R)
Celtis mississippiensis
Ulmus americana
Ulmus crassifolia
Morus rubra
Phoradendron flavescens
Atriplex canescens
Blitum capitatum
Chenopodium album
Cercocarpus montanus
Crataegus marshallii
Crataegus spathulata
Crataegus texana
Padus serotina
Prunus americana
Gleditsia triacanthos
Mimosa strigillosa
Prosopis glandulosa
Cercis canadensis
Amorpha canescens
Amorpha fruticosa
Ptelea mollis
Zanthoxylum clavaherculis
Rhoeidium microphyllum
Rhus lanceolata
Schmaltzia trilobata
Toxicodendron radicans
Zizyphus lycioides
Sapindus drummondii
Acer negundo
Cissus incisa
Parthenocissus quinquefolia
Vitis monticola
Opuntia leptocaulis
Opuntia macrorhiza
Nuttallia nuda
Cornus asperifolia
Bumelia lanuginosa
Fraxinus texensis
Fraxinus viridis

Asclepias tuberosa
Gonolobus albidus
Androcera rostrata
Datura stramonium
Achillea millefolium
Helianthus annuus
Vernonia fasciculata
Vernonia interior

The birds of this area consist of the following species:

Podilymbus podiceps podiceps
Nyctanassa violacea (R)
Nycticorax nycticorax naevius
Florida caerulea caerulea (R)
Leucophoyx thula thula (R)
Ardea herodias wardi
Ardea herodias treganzai
Mycteria americana (R)
Aix sponsa (R)
Spatula clypeata (R)
Querquedula discors (R)
Anas platyrhyncha platyrhyncha (R)
Coragyps urubu urubu
Cathartes aura septentrionalis
Cerchneis sparveria deserticola
Planofalco mexicanus (R)
Buteo borealis borealis
Buteo lineatus alleni (R)
Buteo swainsoni
Buteo regalis (R)
Haliaeetus leucocephalus leucocephalus (R)
Aquila chrysaetos canadensis (R)
Accipiter cooperii (R)
Accipiter velox (R)
Circus cyaneus hudsonius (R)
Ictinia misisippiensis
Elanoides forficatus forficatus (R)
Meleagris gallopavo silvestris
Callipepla squamata pallida
Colinus virginianus virginianus
Oxyechus vociferus vociferus
Numenius americanus americanus
Actitis macularia
Bartramia longicauda (R)
Himantopus mexicanus
Recurvirostra americana
Sternula albifrons antillarum
Zenaidura macroura marginella
Geococcyx californianus
Coccyzus americanus americanus
Colaptes auratus luteus
Centurus carolinus
Melanerpes erythrocephalus erythrophthalmus
Dryobates scalaris symplectus
Dryobates pubescens pubescens (R)
Dryobates villosus villosus
Streptoceryle alcyon alcyon
Bubo virginianus pallescens
Otus asio aikeni
Tyto alba pratincola
Phalaenoptilus nuttallii nuttallii
Chordeiles minor howelli
Horizopus richardsonii richardsonii
Empidonax traillii brewsteri
Sayornis sayus
Myiarchus cinerascens cinerascens
Myiarchus crinitus crinitus
Tyrannus verticalis
Tyrannus tyrannus tyrannus
Muscivora forficata
Toxostoma rufa longicauda
Mimus polyglottos leucopterus
Sialia sialis sialis
Polioptila caerulea caerulea
Catherpes mexicanus polioptilus
Salpinctes obsoletus obsoletus
Troglodytes aedon parkmanii (R)
Penthestes carolinensis agilis
Cyanocitta cristata bromia
Corvus brachyrhynchos brachyrhynchos
Corvus cryptoleucus
Corvus corax sinuatus
Lanius ludovicianus excubitorides
Vireo bellii bellii
Vireo griseus griseus
Vireosylva gilva gilva
Hirundo rustica erythrogastris
Riparia riparia riparia

Stelgidopteryx serripennis serripennis
Petrochelidon albifrons albifrons
Progne subis subis
Icteria virens longicauda
Geothlypis trichas occidentalis
Dendroica aestiva morcomi
Xanthocephalus xanthocephalus
Agelaius phoeniceus fortis
Icterus bullockii bullockii
Icterus galbula
Icterus spurius
Euphagus cyanocephalus
Quiscalus quiscula aeneus
Molothrus ater ater
Richmondena cardinalis cardinalis
Richmondena cardinalis magnirostris
Guiraca caerulea lazula
Passerina ciris pallidior
Spizella passerina passerina (R)
Amphispiza bilineata bilineata
Peucaea cassinii
Pooecetes gramineus confinis
Chondestes grammacus strigatus
Spiza americana
Astragalinus tristis tristis (R)

Great Plains Lacustrian Association.

This includes the lakes and ponds of the Great Plains. Many of these bodies of water are salt or alkaline, and have about their borders only a scanty growth of salt grass. Some of the fresh water ponds have well sodded shores, or in some cases a fringe of marsh. The vegetation is limited, and the influence of this paucity is evident in the scarcity of bird life.

The principal plants are:

Typha latifolia
Potomogeton pectinatus
Sagittaria latifolia
Sagittaria longiloba
Distichlis spicata
Carex stipata
Cyperus esculentus
Scirpus validus
Lemna minor
Spirodela polyrrhiza
Populus deltoides
Persicaria emersa
Castalia elegans
Tillaea drummondii

The birds frequenting these bodies of water are comprised in the following list:

Botaurus lentiginosus
Nycticorax nycticorax naevius
Florida caerulea caerulea (R)
Ardea herodias wardi
Ardea herodias treganzai
Mycteria americana (R)
Spatula clypeata (R)
Querquedula discors (R)
Anas platyrhyncha platyrhyncha (R)
Coragyps urubu urubu
Cathartes aura septentrionalis
Buteo swainsoni
Haliaeetus leucocephalus leucocephalus (R)
Accipiter cooperii (R)
Accipiter velox (R)
Circus cyaneus hudsonius (R)
Fulica americana
Oxyechus vociferus vociferus
Podasocys montanus
Numenius americanus americanus

Actitis macularia
Himantopus mexicanus
Recurvirostra americana
Zenaidura macroura marginella
Streptoceryle alcyon alcyon
Otus asio aikeni
Chordeiles minor howelli
Tyrannus tyrannus tyrannus
Muscivora forficata
Mimus polyglottos leucopterus
Corvus brachyrhynchos brachyrhynchos
Corvus cryptoleucus
Corvus corax sinuatus
Hirundo rustica erythrogastris
Stelgidopteryx serripennis serripennis
Petrochelidon albifrons albifrons
Progne subis subis
Xanthocephalus xanthocephalus
Agelaius phoeniceus fortis
Euphagus cyanocephalus
Quiscalus quiscula aeneus
Molothrus ater ater

Central Chaparral Association.

This is the area of chaparral, cedar brakes, and low oak woods on the uplands of the broken region in central and west central Texas, including the southern extension of the Upper Cross Timbers; but excluding the sometimes rather extensive open grassy areas. This chaparrel rarely develops into a tall forest, but is in many places dense, and clothes both hills and rolling lands. It forms thus an excellent cover for brush-dwelling birds.

The characteristics of the vegetation may be seen from the following list of plants:

Cheilanthes tomentosa
Pellaea flexuosa
Pellaea mucronata
Pinus cembroides
Juniperus sabinoides
Ephedra nevadensis
Dasylirion texanum
Nolina texana
Quamasia hyacinthina
Yucca glauca
Yucca rupicola
Yucca stricta
Yucca treculeana
Quercus brayi
Quercus breviloba
Quercus cinerea
Quercus durandi
Quercus fusiformus
Quercus laceyi
Quercus marylandica
Quercus palustris
Quercus schneckii
Quercus stellata
Quercus undulata
Quercus virginiana
Celtis occidentalis
Erigonum alatum
Atriplex canescens
Acleisanthes longiflora
Allionia linearis
Talinum lineare
Paronychia jamesii
Odostemon trifoliolatus
Delphinium carolinianum
Geum vernum
Prunus minutiflora
Acacia greggii
Acacia roemeriana
Acacia tortuosa
Acuan velutina
Mimosa biuncifera
Mimosa fragrans

Morongia uncinata
Prosopis glandulosa
Cassia pumilio
Cassia roemeriana
Cercis occidentalis
Hoffmannseggia densiflora (R)
Krameria secundiflora
Astragalus missouriensis
Astragalus wrightii
Broussonetia secundiflora
Eysenhardtia amorphoides
Indigofera leptosepala
Parosela formosa
Parosela frutescens
Parosela lasiathera
Psoralea cyphocalyx
Zornia bracteata
Linum multicaule
Linum rupestre
Covillea glutinosa (R)
Koeberlinia spinosa (R)
Ptelea mollis
Rutosma texanum
Zanthoxylum fruticosum
Polygala alba
Acalypha lindheimeri
Croton corymbulosus
Croton fruticulosus
Croton neomexicanus
Stillingia sylvatica
Tithymalopsis wrightii
Tragia nepetaefolia
Tragia nigricans
Rhoeidium microphyllum
Rhus lanceolata
Rhus virens
Schmaltzia trilobata
Ceanothus ovatus
Colubrina texensis
Condalia spathulata
Microrhamnus ericoides
Zizyphus obtusifolius
Ungnadia speciosa
Parthenocissus heptaphylla
Vitis cordefolia
Callirhoe digitata
Sida diffusa
Echinocactus texensis
Echinocereus caespitosus
Mamillaria heyderi
Mamillaria missouriensis
Opuntia arborescens (R)
Opuntia engelmanni
Opuntia leptocaulis
Opuntia lindheimeri
Gaura sinuata
Arbutus texana
Brayodendron texanum
Bumelia lanuginosa
Menodora heterophylla
Apocynum cannabinum
Vincetoxicum biflorum
Evolvulus pilosus
Gilia rigidula
Coldenia canescens
Lippia ligustrina
Hedeoma reverchonii
Salvia farinacea
Scutellaria resinosa
Lycium berlandieri
Lycium carolinianum
Castilleja lindheimeri
Pentstemon guadalupensis
Ibervillea lindheimeri
Ibervillea tripartita
Campanula reverchonii
Lygodesmia aphylla
Aciphyllaea acerosa
Amblyolepis setigera
Berlandiera lyrata
Flourensia cernua
Gaillardia simplex
Gymnolomia tenuifolia
Laphamia halimifolia
Machaeranthera tanacetifolia
Melampodium leucanthum
Psilostrophe tagentinae
Tetragonotheca texana
Thelesperma ambiguum
Thelesperma subsimplicifolium
Thymophylla pentachaeta

Its birds are as follows:

Coragyps urubu urubu
Cathartes aura septentrionalis
Cerchneis sparveria sparveria
Polyborus cheriway auduboni
Buteo borealis borealis
Buteo lineatus alleni
Buteo albonotatus albonotatus
Buteo swainsoni
Haliaeetus leucocephalus leucocephalus (R)
Aquila chrysaetos canadensis (R)
Accipiter cooperii (R)
Accipiter velox (R)
Circus cyaneus hudsonius (R)
Ictinia misisippiensis (R)
Meleagris gallopavo intermedia (R)
Cyrtonyx montezumae mearnsi
Callipepla squamata pallida
Colinus virginianus texanus
Sardafella inca (R)
Zenaidura macroura marginella
Geococcyx californianus
Coccyzus americanus americanus
Centurus aurifrons
Centurus carolinus
Balanosphyra formicivora formicivora (R)
Melanerpes erythrocephalus erythrocephalus
Phloeotomus pileatus pileatus
Chordeiles minor aserriensis
Chordeiles minor howelli
Archilochus alexandri
Archilochus colubris
Horizopus virens
Empidonax traillii brewsteri (R)
Empidonax minimus (R)
Myiarchus cinerascens cinerascens
Myiarchus crinitus crinitus
Tyrannus tyrannus tyrannus
Muscivora forficata
Mimus polyglottos leucopterus
Sialia sialis sialis
Polioptila caerulea caerulea
Thryomanes bewickii cryptus
Thryothorus ludovicianus ludovicianus
Heleodytes brunneicapillus couesi
Sitta carolinensis carolinensis (=*aikeni*)
Sitta carolinensis cookei
Penthestes carolinensis agilis
Baeolophus atricristatus sennetti
Baeolophus bicolor
Cyanocitta cristata cristata (=*florincola*)
Cyanocitta cristata bromia
Aphelocoma californica texana
Corvus brachyrhynchos brachyrhynchos
Corvus brachyrhynchos paulus
Corvus cryptoleucus (R)
Corvus corax sinuatus
Lanius ludovicianus excubitorides
Vireo bellii bellii
Vireo griseus griseus
Vireo atricapillus
Lanivireo flavifrons
Hirundo rustica erythrogastris
Icteria virens virens
Dendroica chrysoparia
Dendroica aestiva aestiva (R)
Xanthocephalus xanthocephalus (R)
Icterus bullockii bullockii
Icterus spurius
Quiscalus quiscula aeneus
Molothrus ater ater
Molothrus ater obscurus
Richmondena cardinalis canicauda
Pyrrhuloxia sinuata texana
Guiraca caerulea lazula
Passerina ciris pallidior
Passerina amoena
Passerina cyanea
Pipilo fuscus mesoleucus
Spizella pusilla pusilla
Spizella passerina passerina
Amphispiza bilineata bilineata
Peucaea cassinii
Aimophila ruficeps eremoeca

Ammodramus savannarum bimaculatus
Chondestes grammacus strigatus
Spiza americana
Astragalimus psaltria psaltria

Central Riparian Association.

This comprises the stream valleys and canyons of the central broken region, and includes the edges of the Edwards Plateau. These in most cases support a rich distinctive plant growth, more arboreal in character than that of the upland chaparral, and as a consequence they attract a different assemblage of birds. This area is, like the chaparral, an excellent place for birds, and the list is comparatively a long one.

The principal plants are:

Botrychium virginianum
Adiantum capillusveneris
Dryopteris normalis
Pellaea atropurpurea
Woodsia obtusa
Juniperus sabinoides
Taxodium distichum
Typha latifolia
Arisaema dracontium
Tillandsia recurvata
Dasylirion texanum
Yucca glauca
Yucca rupicola
Smilax bonanox
Smilax rotundifolia
Populus deltoides
Salix nigra
Hicoria myristicaeformis
Hicoria pecan
Juglans rupestris
Quercus brayi
Quercus macrocarpa
Quercus muhlenbergii
Quercus nigra
Quercus texana
Quercus virginiana
Celtis mississippiensis
Celtis occidentalis
Ulmus americana
Ulmus crassifolia
Ulmus pubescens
Morus rubra
Phoradendron flavescens
Aristolochia longifolia
Portulaca lanceolata
Talinum calycinum
Talinum lineare
Mollugo cerviana
Aquilegia canadensis
Clematis drummondii
Delphinium carolinianum
Odostemon trifoliolatus
Benzoin aestivale
Lesquerella densiflora
Platanus occidentalis
Sedum torreyi
Rosa arkansana
Rosa foliolosa
Crataegus texana
Malus coronaria
Padus serotina
Prunus rivularis
Acacia roemeriana
Leucaena retusa
Morongia uncinata
Prosopis glandulosa
Cercis occidentalis
Amorpha fruticosa
Eysenhardtia amorphoides
Sophora affinis
Kallstroemia maxima
Ptelea mollis
Zanthoxylum fruticosum
Croton corymbulosus

Stillingia dentata
Cotinus cotinoides
Rhus lanceolata
Rhus virens
Schmaltzia crenata
Toxicodendron radicans
Ilex decidua
Sapindus drummondi
Ungnadia speciosa
Ceanothus ovatus
Rhamnus caroliniana
Aesculus octandra
Parthenocissus quinquefolia
Vitis candicans
Vitis cordifolia
Tilia americana
Sida physocalyx
Sphaeralcea cuspidata
Opuntia engelmanni
Gaura sinuata
Gaura suffulta
Hartmannia speciosa
Cornus asperifolia
Arbutus texana
Brayodendron texanum
Bumelia lanuginosa
Bumelia lycioides
Forestiera neomexicana
Fraxinus viridis
Menodora heterophylla
Marilaunidium hispidum
Cryptanthe texana
Lappula occidentalis
Lippia ligustrina
Lycium carolinianum
Nicotiana glauca
Quincula lobata
Solanum elaeagnifolium
Martynia louisiana
Cephalanthus occidentalis
Lonicera albiflora
Lonicera sempervirens
Symphoricarpos symphoricarpos
Viburnum prunifolium
Cucurbita foetidissima
Ibervillea lindheimeri
Ibervillea tripartita
Xanthium canadense
Berlandiera lyrata
Helianthus giganteus
Machaeranthera tanacetifolia
Senecio aureus

The list of birds is as follows:

Nycticorax nycticorax naevius
Butorides virescens virescens
Florida caerulea caerulea
Leucophoyx thula thula (R)
Casmerodius alba egretta (R)
Ardea herodias wardi
Mycteria americana (R)
Aix sponsa (R)
Spatula clypeata (R)
Querquedula discors
Coragyps urubu urubu
Cathartes aura septentrionalis
Cerchneis sparveria sparveria
Polyborus cheriway
Buteo borealis borealis
Buteo lineatus alleni
Buteo albonotatus albonotatus
Buteo swainsoni
Haliaeetus leucocephalus leucocephalus (R)
Aquila chrysaetos canadensis (R)
Accipiter cooperii (R)
Accipiter velox (R)
Circus cyaneus hudsonius (R)
Ictinia misisippiensis
Elanoides forficatus forficatus (R)
Pandion haliaetus carolinensis (R)
Meleagris gallopavo intermedia
Cyrtonyx montezumae mearnsi
Callipepla squamata pallida
Colinus virginianus texanus
Fulica americana (R)
Oxyechus vociferus vociferus
Actitis macularia
Scardafella inca (R)
Zenaidura macroura marginella
Geococcyx californianus
Coccyzus americanus americanus

Coccyzus americanus occidentalis
Centurus aurifrons
Centurus carolinus
Balanosphyra formicivora formicivora (R)
Melanerpes erythrocephalus erythrocephalus
Phloeotomus pileatus pileatus
Dryobates scalaris symplectus
Dryobates pubescens pubescens
Chloroceryle americana septentrionalis
Streptoceryle alcyon alcyon
Bubo virginianus pallescens
Otus asio hasbroucki
Strix varia helveola
Tyto alba pratincola
Antrostomus carolinensis
Phalaenoptilus nuttallii nuttallii
Chordeiles minor aserriensis
Chordeiles minor howelli
Archilochus alexandri
Archilochus colubris
Horizopus virens
Empidonax virescens
Empidonax traillii brewsteri
Empidonax minimus (R)
Sayornis phoebe
Sayornis nigricans semiater
Myiarchus cinerascens cinerascens
Myiarchus crinitus crinitus
Tyrannus tyrannus tyrannus
Muscivora forficata
Mimus polyglottos leucopterus
Sialia sialis sialis
Polioptila caerulea caerulea
Catherpes mexicanus polioptilus
Salpinctes obsoletus obsoletus
Thryomanes bewickii cryptus
Thryothorus ludovicianus ludovicianus
Heleodytes bruneicapillus couesi
Sitta carolinensis carolinensis (=*aikeni*)
Sitta carolinensis cookei
Penthestes carolinensis agilis
Baeolophus atricristatus sennetti
Baeolophus bicolor
Cyanocitta cristata cristata (=*florincola*)
Aphelocoma californica texana
Corvus brachyrhynchos brachyrhynchos
Corvus brachyrhynchos paulus
Corvus cryptoleucus (R)
Corvus corax sinuatus
Lanius ludovicianus excubitorides
Vireo bellii bellii
Vireo griseus griseus
Vireo atricapillus
Lanivireo flavifrons
Vireosylva olivacea
Hirundo rustica erythrogastris
Stelgidopteryx serripennis serripennis
Petrochelidon albifrons albifrons
Petrochelidon albifrons tachina
Petrochelidon fulva pallida (R)
Progne subis subis
Icteria virens virens
Oporornis formosus
Dendroica dominica albilora
Dendroica chrysoparia
Dendroica aestiva aestiva (R)
Compsothlypis americana ramalinae
Mniotilta varia
Xanthocephalus xanthocephalus
Agelaius phoeniceus predatorius (R)
Icterus bullockii bullockii
Icterus spurius
Quiscalus quiscula aeneus
Molothrus ater ater
Molothrus ater obscurus
Piranga rubra rubra
Richmondena cardinalis canicauda
Pyrrhuloxia sinuata texana
Guiraca caerulea lazula
Passerina ciris pallidior
Passerina amoena
Passerina cyanea
Pipilo fuscus mesoleucus
Spizella pusilla pusilla
Spizella passerina passerina
Amphispiza bilineata bilineata

Peucaea cassinii
Aimophila ruficeps eremoeca
Chondestes grammacus strigatus
Spiza americana
Astragalinus psaltria psaltria

Central Grass Association.

The grassy and other open areas on the uplands of the central broken region of the State have a distinctive though less striking fauna and flora. The vegetation consists principally of grasses and flowering herbaceous plants, and includes a few scattered cactuses. The birds are prairie inhabiting or open land species.

The most characteristic plants are included in the following list:

Andropogon emersus
Aristida bromoides
Aristida lanosa
Aristida oligantha
Bouteloua eriopoda
Bouteloua hirsuta
Bouteloua texana
Bouteloua trifida
Chaetochloa geniculata
Chaetochloa macrostachya
Chloris cucullata
Chloris verticillata
Eragrostis curtipedicellata
Eragrostis pectinacea
Eragrostis refracta
Eragrostis sessilispica
Erianthus contortus
Eriochloa sericea
Festuca sciurea
Gymnopogon ambiguus
Hilaria cenchroides
Holcus halapensis
Hordeum jubatum
Hordeum pusillum
Leptochloa nealleyi
Limnodea arkansana
Melica mutica
Melica porteri
Muhlenbergia capillaris
Panicum ciliatissimum
Panicum dichotomiflorum
Panicum fasciculatum reticulatum
Panicum filipes
Panicum hallii
Panicum helleri
Panicum lindheimeri
Panicum pedicellatum
Panicum perlongum
Panicum plenum
Panicum ramisetum
Panicum reverchoni
Panicum texanum
Panicum virgatum
Poa arachnifera
Schedonnardus paniculatus
Sitanion hystrix
Sorghastrum nutans
Sphenopholis hallii
Sphenopholis interrupta
Sphenopholis obtusata
Sphenopholis pallens longiflora
Sporobolus argutus
Stipa leucotricha
Trichloris pluriflora
Tridens avenaceus
Tridens strictus
Tridens texanus
Nolina texana
Quamasia hyacinthina
Yucca glauca
Yucca stricta
Acleisanthes longiflora
Delphinium macroceratilis
Delphinium vimineum
Ranunculus cuneiformis
Ranunculus macranthus

Argemone platyceras
Lesquerella gordoni
Lesquerella gracilis
Lesquerella sessilis
Acuan velutina
Morongia uncinata
Cassia pumilio
Astragalus missouriensis
Astragalus nuttallianus
Indigofera leptosepala
Lupinus subcarnosus
Psoralea cuspidata
Parosela lasiathera
Zornia bracteata
Linum multicaule
Linum rigidum
Ionoxalis vespertilionis
Kallstroemia maxima
Rutosma texanum
Chamaesyce lata
Croton corymbulosus
Tragia neptaefolia
Callirrhoe digitata
Callirrhoe involucrata
Sida physocalyx
Echinocactus texensis
Echinocereus caespitosus
Mamillaria heyderi
Mamillaria missouriensis
Mentzelia oligosperma
Gaura coccinea
Gaura sinuata
Hartmannia speciosa
Megapterium missouriense
Pentstemon acuminatus
Meriolix serrulata
Raimannia laciniata
Apocynum cannabinum
Asclepias longicornu
Asclepiodora decumbens
Vincetoxicum biflorum
Pentstemon cobaea
Pentstemon grandiflorus
Penstemon helleri
Lygodesmia aphylla
Pinaropappus roseus
Convolvulus incanus
Galia acerosa
Phlox drummondii
Coldenia canescens
Verbena bipinnatifida
Verbena hastata
Verbena officinalis
Verbena xutha
Hedeoma lata
Hedeoma nana
Melosmon laciniatum
Monarda citriodora
Salvia farinacea
Salvia texana
Scutellaria resinosa
Quincula lobata
Solanum elaeagnifolium
Solanum torreyi
Castilleja lindheimeri
Amblyolepis setigera
Aphanostephus ramosissimus
Centaurea americana
Cirsium discolor
Crassina grandiflora
Encelia calva
Gaillardia pinnatifida
Gaillardia pulchella
Gaillardia simplex
Hymenoxys odorata
Machaeranthera tanacetifolia
Parthenium tyratum
Ratibida pulchella
Sideranthus spinulosus
Tetraneuris scaposa
Thelesperma subsimplicifolium

The birds found here are as follows:

Coragyps urubu urubu
Cathartes aura septentrionalis
Cerchneis sparveria sparveria
Polyborus cheriway auduboni
Buteo borealis borealis
Buteo lineatus alleni
Buteo albonotatus albonotatus
Buteo swainsoni
Haliaeetus leucecephalus leucocephalus (R)

Aquila chrysaetos canadensis (R)
Accipiter cooperii (R)
Accipiter velox (R)
Circus cyaneus hudsonius (R)
Meleagris gallopavo intermedia
Tympanuchus americanus attwateri
Cyrtonyx montezumae mearnsi
Callipepla squamata pallida
Colinus virginianus texanus
Oxyechus vociferus vociferus
Scardafella inca (R)
Zenaidura macroura marginella
Geococcyx californianus
Speotyto cunicularia hypugaea
Otus asio hasbroucki
Strix varia helveola
Tyto alba pratincola
Phalaenoptilus nuttallii nuttallii (R)
Chordeiles minor aserriensis
Chordeiles minor howelli
Archilochus colubris
Tyrannus tyrannus tyrannus
Muscivora forficata
Mimus polyglottos leucopterus
Sialia sialis sialis
Corvus brachyrhynchos brachyrhynchos
Corvus brachyrhynchos paulus
Corvus cryptoleucus (R)
Corvus corax sinuatus
Lanius ludovicianus excubitoides
Hirundo rustica erythrogastris
Stelgidopteryx serripennis serripennis
Petrochelidon albifrons albifrons
Petrochelidon albifrons tachina
Progne subis subis
Sturnella magna magna
Sturnella magna hoopesi
Sturnella neglecta neglecta
Icterus bullockii bullockii
Icterus spurius
Quiscalus quiscula aeneus
Molothrus ater ater
Molothrus ater obscurus
Guiraca caerulea lazula (R)
Passerina ciris pallidior (R)
Passerina amoena (R)
Passerina cyanea
Pipilo fuscus mesoleucus
Spizella pusilla pusilla
Spizella passerina passerina
Aimophila ruficeps eremoeca
Ammodramus savannarum bimaculatus
Chondestes grammacus strigatus
Spiza americana
Passer domesticus domesticus
Astragalinus psaltria psaltria

Southern Brush Association.

This consists of the chaparral areas of central southern Texas, south and southeast of the Edwards Plateau, exclusive of the stream valleys and the open grassy tracts. This chaparral grows on level or rolling land, and varies from a low straggling semi-arid growth to a very dense jungle, though not to any extent taking an arboreal character. It is made up of a great variety of shrubs and low trees, many of them thorny; together with cactuses, yuccas, agaves, and some flowering herbaceous plants. Owing to the character of its vegetation, and to a less extent its geographical position, this association forms one of the most attractive places for birds to be found in the State, and the total number of spe-

cies occurring here is correspondingly large. Thicket dwelling birds, of course, predominate.

The facies of the vegetation is evident from the subjoined list of plants.

Ephedra nevadensis
Cenchrus carolinianus
Commelina crispa
Tillandsia baileyi
Tillandsia recurvata
Yucca arkansana
Yucca rupicola
Yucca treculeana
Smilax bonanox
Agava rigida
Manfreda maculosa
Manfreda virginica
Cerothamnus cerifera
Quercus minor
Quercus virginiana
Momisia pallida
Phoradendron flavescens
Nyctaginia capitata
Odostemon trifoliolatus
Delphinium carolinianum
Persea borbonia
Argemone mexicana
Argemone platyceras
Argemone rosea
Sedum texanum
Acacia amentacea
Acacia berlandieri
Acacia constricta
Acacia greggii
Acacia roemeriana
Acacia tortuosa
Acacia wrightii
Leucaena glauca
Leucaena retusa
Mimosa berlandieri
Mimosa fragrans
Mimosa lindheimeri
Mimosa malacophylla
Mimosa texana
Morongia latidens
Morongia roemeriana
Morongia uncinata
Prosopis glandulosa
Vachellia farnesiana
Cercidium floridum
Cercidium texanum
Parkinsonia aculeata
Broussonetia secundiflora
Coursetia axillaris
Eysenhardtia amorphoides
Parosela domingensis
Parosela formosa
Parosela lasiathera
Parosela laxiflora
Parosela nana
Covillea glutinosa
Guaiacum sanctum
Porlieria angustifolia
Zanthoxylum fagara
Koeberlinia spinosa
Castela nicholsonii
Bernardia myricaefolia
Rhoeidium microphyllum
Schaefferia cuneifolia
Colubrina texensis
Condalia obovata
Karwinskia humboldtiana
Microrhamnus ericoides
Rhamnus caroliniana
Zizyphus obtusifolius
Callirhoe pedata
Malvastrum tricuspidatum
Malvastrum wrightii
Echinocactus brevihamatus
Echinocactus sinuatus
Echinocactus texensis
Echinocactus wrightii
Echinocereus caespitosus
Echinocereus enneacanthus
Echinocereus poselgeri
Echinocereus stramineus
Mamillaria calcarata
Mamillaria heyderi
Mamillaria meiacantha
Mamillaria missouriensis
Mamillaria radiosa

Mamillaria sphaerica
Mamillaria texana
Opuntia arborescens
Opuntia engelmanni
Opuntia leptocaulis
Gaura brachycarpa
Gaura sinuata
Batodendron arboreum
Brayodendron texanum
Bumelia lanuginosa
Forestiera angustifolia
Eustoma russellianum
Phlox drummondii
Ehretia elliptica
Lithospermum matamorense
Lantana camara
Lippia ligustrina
Verbena ciliata
Lycium carolinianum
Nicotiana trigonophylla
Solanum elaeagnifolium
Solanum triquetrum
Castilleja indivisa
Castilleja lindheimeri
Leucophyllum texanum
Ibervillea lindheimeri
Centaurea americana
Coreopsis nuecensis
Helianthus annuus
Helianthus cucumerifolius
Ratibida columifera

The list of birds follows:

Dendrocygna autumnalis
Coragyps urubu urubu
Cathartes aura septentrionalis
Cerchneis sparveria sparveria
Rhynchofalco fuscocoerulescens septentrionalis
Polyborus cheriway auduboni
Buteo borealis borealis
Buteo lineatus alleni
Buteo lineatus texanus
Buteo albonotatus albonotatus
Buteo swainsoni
Buteo platypterus platypterus (R)
Tachytriorchis albicaudatus sennetti
Urubitinga anthracina (R)
Haliaeetus leucocephalus leucocephalus (R)
Parabuteo unicinctus harrisi
Accipiter cooperii (R)
Accipiter velox (R)
Circus cyaneus hudsonius (R)
Ictinia misisippiensis
Elanus leucurus majusculus (R)
Elanoides forficatus forficatus (R)
Ortalis vetula vetula
Meleagris gallopavo intermedia
Callipepla squamata castanogastris
Colinus virginianus texanus
Chaemepelia passerina pallescens
Scardafella inca
Zenaidura macroura marginella
Melopelia asiatica asiatica
Leptotila fulviventris angelica
Chloroenas flavirostris flavirostris
Crotophaga sulcirostris sulcirostris
Geococcyx californianus
Coccyzus americanus americanus
Centurus aurifrons
Centurus carolinus
Phloeotomus pileatus pileatus (R)
Dryobates scalaris symplectus
Glaucidium brasilianum ridgwayi
Speotyto cunicularia hypugaea
Bubo virginianus virginianus
Bubo virginianus pallescens
Otus asio mccallii
Strix varia helveola
Tyto alba pratincola
Antrostomus carolinensis
Phalaenoptilus nuttalli nuttalli
Nyctidromus albicollis merrilli
Chordeiles minor aserriensis
Chordeiles acutipennis texensis
Amazilia yucatanensis chalconota
Camptostoma imberbe
Pyrocephalus rubinus mexicanus

Horizopus virens
Empidonax minimus (R)
Myiarchus cinerascens cinerascens
Myiarchus magister nelsoni
Myiarchus crinitus crinitus
Pitangus sulphuratus derbianus
Muscivora forficata
Toxostoma curvirostris curvirostris
Toxostoma longirostris sennetti
Mimus polyglottos leucopterus
Sialia sialis sialis (R)
Sialia sialis episcopus
Polioptila melanura
Polioptila caerulea caerulea
Polioptila caerulea obscura
Salpinctes obsoletus obsoletus (R)
Thryomanes bewickii cryptus
Thryothorus ludovicianus ludovicianus
Thryothorus ludovicianus lomitensis
Heleodytes brunneicapillus couesi
Auriparus flaviceps flaviceps
Penthestes carolinensis agilis
Baeolophus atricristatus atricristatus
Baeolophus atricristatus sennetti
Baeolophus bicolor
Xanthoura luxuosa glaucescens
Corvus brachyrhynchos paulus (R)
Corvus cryptoleucus
Lanius ludovicianus exubitorides
Vireo bellii bellii
Vireo griseus griseus
Vireo griseus micrus
Lanivireo flavifrons (R)
Hirundo rustica erythrogastris
Stelgidopteryx serripennis serripennis
Progne subis subis
Icteria virens virens
Icteria virens longicauda
Chamaethlypis poliocephala poliocephala
Geothlypis trichas trichas
Dendroica aestiva aestiva (R)
Icterus bullockii bullockii
Icterus cucullatus sennettii
Icterus melanocephalus audubonii
Icterus spurius
Megaquiscalus major macrourus
Quiscalus quiscula aeneus
Molothrus ater obscurus
Tangavius aeneus involucratus
Richmondena cardinalis canicauda
Pyrrhuloxia sinuata texana
Guiraca caerulea lazula
Passerina versicolor versicolor
Passerina ciris pallidior
Arremonops rufivirgatus rufivirgatus
Amphispiza bilineata bilineata
Peucaea cassinii
Ammodramus savannarum bimaculatus
Chondestes grammacus strigatus
Spiza americana
Astragalinus psaltria psaltria

Southern Riparian Association.

In this are included the stream valleys and ponds of the great southern chaparral belt of central southern Texas. The streams are mostly fringed, and the ponds more or less surrounded, in addition to thickets, by considerable arboreal vegetation, but sometimes this is entirely lacking. But even the herbaceous growth, composed as it is in material part of hydrophilous species, gives a distinctive tone to this association. The arboreal and hydrophytic character of the vege-

tation has its direct influence here on the bird life, as an examination of the list of species will show.

The plants of this area are as follows:

Usnea barbata
Typha latifolia
Sagittaria platyphylla
Arundinaria macrosperma
Arundo donax
Bromus unioloides
Bulbilis dactyloides
Cenchrus carolinianus
Cenchrus echinatus
Chaetochloa setosa
Dactyloctenium aegyptium
Eleusine indica
Eragrostis capillaris
Eriochloa punctata
Holcus halapensis
Limnodea arkansana
Paspalum distichum
Phragmites phragmites
Sphenopholis obtusata
Sporobolus buckleyi
Sporobolus wrightii
Syntherisma sanguinalis
Cyperus articulatus
Cyperus buckleyi
Cyperus cyrtolepis
Cyperus erythrorhizos
Cyperus fendlerianus
Cyperus flavescens
Cyperus hospan
Cyperus ochraceus
Cyperus surinamensis
Scirpus validus
Sabal mexicana
Dendropogon usneoides
Tillandsia baileyi
Tillandsia recurvata
Yucca treculeana
Smilax bonanox
Manfreda variegata
Populus deltoides
Salix nigra
Hicoria pecan
Quercus virginiana
Celtis occidentalis
Momisia pallida
Ulmus americana
Ulmus crassifolia
Phoradendron flavescens
Mirabilis wrightiana
Quamoclidion multiflorum
Nelumbo lutea
Nymphaea advena
Nymphaea microcarpa
Nymphaea ovata
Clematis drummondii
Halerpestes cymbalaria
Ranunculus macranthus
Argemone mexicana
Argemone platyceras
Argemone rosea
Lesquerella lasiocarpa
Platanus occidentalis (R)
Fallugia paradoxa
Padus serotina (R)
Havardia brevifolia
Prosopis glandulosa
Vachellia farnesiana
Parkinsonia aculeata
Broussonetia secundiflora
Daubentonia longifolia
Ptelea mollis
Rhamnus caroliniana
Sapindus drummondii
Vitis candicans
Vitis cinerea
Callirrhoe geranioides
Callirrhoe involucrata
Heimia salicifolia
Echinocereus berlandieri
Echinocereus dubius
Echinocereus procumbens
Opuntia engelmanni
Opuntia leptocaulis
Bumelia lanuginosa
Forestiera angustifolia
Fraxinus berlandieri
Phlox villosissima
Ehretia elliptica

Lippia ligustrina
Datura meteloides
Nicotiana repanda
Leucophyllum texanum
Ruellia tuberosa
Tetramerium platystegium
Sambucus mexicana
Ibervillea lindheimeri
Ibervillea tenuisecta
Baccharis glutinosa
Helenium amphibolum
Helenium autumnale
Helenium elegans
Helenium microcephalum
Helenium ooclinum
Helenium tenuifolium
Helianthus annuus
Helianthus ciliaris
Helianthus petiolaris
Isocoma drummondii
Stanfieldia nealleyi
Varilla texana

The birds occurring here are even more numerous than those of the dense upland chaparral, and are given in the following list:

Podilymbus podiceps podiceps
Colymbus dominicus brachypterus
Ixobrychus exilis exilis (R)
Botaurus lentiginosus (R)
Nycticorax nycticorax naevius
Butorides virescens virescens
Florida caerulea caerulea
Hydranassa tricolor ruficollis
Leucophoyx thula thula
Casmerodius alba egretta
Ardea herodias wardi
Mycteria americana
Nomonyx dominicus (R)
Aix sponsa (R)
Spatula clypeata (R)
Querquedula discors (R)
Dendrocygna autumnalis
Coragyps urubu urubu
Cathartes aura septentrionalis
Cerchneis sparveria sparveria
Rhynchofalco fuscocoerulescus septentrionalis (R)
Polyborus cheriway auduboni
Buteo borealis borealis
Buteo lineatus alleni
Buteo lineatus texanus
Buteo albonotatus albonotatus
Buteo swainsoni
Buteo platypterus platypterus (R)
Tachytriorchis albicaudatus sennetti
Urubitinga anthracina (R)
Haliaeetus leucocephalus leucocephalus (R)
Parabuteo unicinctus harrisi
Accipiter cooperii (R)
Accipiter velox (R)
Circus cyaneus hudsonius (R)
Ictinia misisippiensis
Elanus leucurus majusculus (R)
Elanoides forficatus forficatus (R)
Pandion haliaetus carolinensis (R)
Ortalis vetula vetula
Meleagris gallopavo intermedia
Callipepla squamata castanogastris
Colinus virginianus texanus
Fulica americana
Gallinula chloropus cachinnans (R)
Porphyrula martinica
Asarcia spinosa gymnostoma (R)
Oxyechus vociferus vociferus
Chaemepelia passerina pallescens
Scardafella inca
Zenaidura macroura marginella
Melopelia asiatica asiatica
Leptotila fulviventris angelica
Chloroenas flavirostris flavirostris
Crotophaga sulcirostris sulcirostris
Geococcyx californianus
Coccyzus americanus americanus
Centurus aurifrons
Centurus carolinus

Phloeotomus pileatus pileatus
Dryobates scalaris symplectus
Chloroceryle americana septentrionalis
Streptoceryle alcyon alcyon
Micropallas whitneyi idonea (R)
Glaucidium brasilianum ridgwayi
Bubo virginianus virginianus
Bubo virginianus pallescens
Otus asio mccallii
Strix varia helveola
Tyto alba pratincola
Antrostomus carolinensis
Phalaenoptilus nuttallii nuttallii
Nyctidromus albicollis merrilli
Chordeiles minor aserriensis
Chordeiles acutipennis texensis
Amazilia yucatanensis chalconota
Camptostoma imberbe
Pyrocephalus rubinus mexicanus
Horizopus virens
Empidonax virescens
Empidonax minimus (R)
Myiarchus cinerascens cinerascens
Myiarchus magister nelsoni
Myiarchus crinitus crinitus
Pitangus sulphuratus derbianus
Tyrannus melancholicus couchii
Muscivora forficata
Toxostoma curvirostris curvirostris
Toxostoma longirostris sennetti
Mimus polyglottos leucopterus
Sialia sialis sialis (R)
Sialia sialis episcopus (R)
Polioptila melanura
Polioptila caerulea caerulea
Polioptila caerulea obscura
Salpinctes obsoletus obsoletus (R)
Thryomanes bewickii cryptus
Thryothorus ludovicianus ludovicianus
Thryothorus ludovicianus lomitensis
Heleodytes brunneicapillus couesi
Auriparus flaviceps flaviceps
Penthestes carolinensis agilis
Baeolophus atricristatus atricristatus
Baeolophus atricristatus sennetti
Baeolophus bicolor
Xanthoura luxuosa glaucescens
Corvus brachyrhynchos paulus (R)
Corvus cryptoleucus
Lanius ludovicianus excubitorides
Vireo bellii bellii
Vireo griseus griseus
Vireo griseus micrus
Lanivireo flavifrons (R)
Vireosylva olivacea
Hirundo rustica erythrogastris
Riparia riparia riparia
Stelgidopteryx serripennis serripennis
Petrochelidon albifrons tachina
Progne subis subis
Icteria virens virens
Icteria virens longicauda
Chamaethlypis poliocephala poliocephala
Geothlypis trichas trichas
Dendroica dominica albilora
Dendroica aestiva aestiva (R)
Compsothlypis pitiayumi nigrilora
Compsothlypis americana ramalinae (R)
Agelaius phoeniceus megapotamus
Icterus bullockii bullockii
Icterus cucullatus sennettii
Icterus melanocephalus audubonii
Icterus spurius
Megaquiscalus major macrourus
Quiscalus quiscula aeneus
Molothrus ater obscurus
Tangavius aeneus involucratus
Piranga rubra rubra
Richmondena cardinalis canicauda
Pyrrhuloxia sinuata texana
Guiraca caerulea lazula
Passerina versicolor versicolor
Passerina ciris pallidior
Sporophila morelleti sharpei
Arremonops rufivirgatus rufivirgatus

Amphispiza bilineata bilineata
Peucaea cassinii
Chondestes grammacus strigatus
Spiza americana
Carpodacus mexicanus frontalis
Astragalinus psaltria psaltria

Southern Grass Association.

Scattered through the chaparral of the central and southern region of the State are many openings or small prairies, most of them grassy and supporting as well a growth of flowering annuals and other herbaceous plants, but lacking either bushes or trees. The birds of these grassy areas are fewer in number than those of the chaparral itself, and are terrestrial species of the open grass land, the brush dwelling and strictly arboreal species being absent, together with nearly all water-fowl and shore-birds.

The conspicuous plants appear in the following list:

Andropogon emersus
Andropogon tener
Bouteloua barbata
Bouteloua hirsuta
Bouteloua trifida
Cenchrus carolinianus
Chaetochloa geniculata
Chaetochloa gracilis
Chaetochloa macrostachya
Chloris cucullata
Chloris petraea
Chloris texana
Chloris verticillata
Distichlis multinervosa
Elyonurus tripsacoides
Erianthus divaricatus
Hilaria mutica
Holcus halapensis
Manisuris cylindrica
Manisuris fasciculata
Nazia aliena
Panicum capillarioides
Panicum ciliatissimum
Panicum fasciculatum reticulatum
Panicum filipes
Panicum firmulum
Panicum hallii
Panicum ramisetum
Panicum reverchoni
Panicum texanum
Paspalum laeve
Sorghastrum nutans
Tridens albescens
Tridens buckleyanus
Tridens congestus
Tripsacum floridanum
Commelina crispa
Tradescantia gigantea
Tradescantia micrantha
Allium mutabile
Yucca arkansana
Agave rigida
Manfreda maculosa
Manfreda virginica
Nemastylis coelestina
Allionia coccinea
Mirabilis jalapa
Nyctaginia capitata
Argemone mexicana
Argemone platyceras
Argemone rosea
Arabis petiolaris
Lesquerella argyrea
Lesquerella gracilis
Lesquerella sessilis
Synthlipsis berlandieri
Morongia uncinata
Chamaecrista procumbens
Krameria secundiflora
Astragalus brazoensis
Astragalus leptocarpus
Astragalus nuttallianus

Baptisia leucophaea
Cracca lindheimeri
Daubentonia longifolia
Galactia canescens
Galactia marginalis
Indigofera leptosepala
Lupinus subcarnosus
Parosela lasiathera
Psoralea cuspidata
Psoralea floribunda
Psoralea rhombifolia
Zornia tetraphylla
Linum rigidum
Acalypha radians
Cnidoscolus stimulosus
Stillingia sylvatica
Callirrhoe lineariloba
Callirrhoe pedata
Phaeralcea lindheimeri
Echinocactus texensis
Echinocereus caespitosus
Echinocereus enneacanthus
Echinocereus stramineus
Mamillaria calcarata
Mamillaria heyderi
Mamillaria meiacantha
Mamillaria missouriensis
Mamillaria radiosa
Mamillaria texana
Gaura coccinea
Gaura drummondii
Gaura suffulta
Gaura tripetala
Hartmannia speciosa
Hartmannia tetraptera
Meriolix serrulata drummondii
Centaurium calycosum
Asclepias longicornu
Asclepiodora decumbens
Convolvulus hermannioides
Evolvulus sericeus
Phlox drummondii
Lantana camara
Verbena bipinnatifida
Verbena canescens
Verbena ciliata
Verbena urticaefolia
Verbena xutha
Monarda citriodora
Scutellaria drummondii
Nicotiana trigonophylla
Solanum elaeagnifolium
Afzelia texana
Aphanostephus skirrobasis
Centaurea americana
Coreopsis cardaminefolia
Coreopsis drummondii
Coreopsis grandiflora
Coreopsis nuecensis
Engelmannia pinnatifida
Filago nivea
Gaillardia amblyodon
Gaillardia lanceolata
Gaillardia pinnatifida
Gaillardia pulchella
Grindelia microcephala
Grindelia squarrosa
Helenium autumnale
Helenium microcephalum
Helenium tenuifolium
Isopappus divaricatus
Ratibida columnifera
Ratibida peduncularis
Rudbeckia hirta
Stevia foliosa
Verbesina encelioides

The birds are included in the following list:

Polyborus cheriway auduboni
Buteo borealis borealis
Buteo albonotatus albonotatus
Buteo swainsoni
Tachytriorchis albicaudatus sennetti
Accipiter cooperii (R)
Accipiter velox (R)
Circus cyaneus hudsonius (R)
Ictinia misisippiensis
Elanus leucurus majusculus (R)
Elanoides forficatus forficatus (R)
Meleagris gallopavo intermedia
Tympanuchus americanus attwateri
Colinus virginianus texanus

Callipepla squamata castanogastris
Oxyechus vociferus vociferus
Chaemepelia passerina pallescens
Scardafella inca
Zenaidura macroura marginella
Melopelia asiatica asiatica (R)
Crotophaga sulcirostris sulcirostris (R)
Geococcyx californianus
Speotyto cunicularia hypugaea
Otus asio mccallii
Strix varia helveola
Tyto alba pratincola
Phalaenoptilus nuttallii nuttallii
Nyctidromus albicollis merrilli
Chordeiles minor aserriensis
Chordeiles acutipennis texensis
Muscivora forficata
Mimus polyglottos leucopterus
Sialia sialis sialis (R)
Sialia sialis episcopus (R)
Baeolophus atricristatus sennetti
Corvus brachyrhynchos paulus (R)
Corvus cryptoleucus
Lanius ludovicianus excubitorides
Hirundo rustica erythrogastris
Stelgidopteryx serripennis serripennis
Petrochelidon albifrons tachina
Progne subis subis
Sturnella magna hoopesi
Icterus bullockii bullockii
Icterus cucullatus sennetti
Icterus spurius
Megaquiscalus major macrourus
Quiscalus quiscula aeneus
Molothrus ater obscurus
Tangavius aeneus involucratus
Guiraca caerulea lazula (R)
Passerina ciris pallidior
Ammodramus savannarum bimaculatus
Chondestes grammacus strigatus
Spiza americana
Passer domesticus domesticus
Carpodacus mexicanus frontalis (R)
Astragalinus psaltria psaltria

Desert Chaparral Association.

The Desert Chaparral Association comprises the chaparral areas of the mesas, plains, and low hills in the desert portion of central western Texas, from about the Devils and Pecos Rivers westward. The chaparral here is, on the whole, of less height and also much more open than that in the central southern part of the State. The large proportion of cactuses, tall yuccas, agaves, and thorny or grayish green shrubs gives it a decidedly desert aspect. The characteristic birds of this area are largely desert species that live in bushes and thickets.

The subjoined list of plants discloses the facies of the flora:

Selaginella lepidophylla
Ephedra antisyphilitica
Ephedra nevadensis
Ephedra torreyana
Hechtia texensis
Dasylirion graminifolium
Dasylirion texanum
Hesperaloe parviflora
Nolina erumpens
Nolina lindheimeri
Nolina texana
Samuela faxoniana

Yucca constricta
Yucca elata
Yucca macrocarpa
Yucca treculeana
Agave lechuguilla
Eriogonum havardii
Eriogonum suffruticosum
Atriplex acanthocarpa
Atriplex canescens
Tidestromia suffruticosa
Abronia angustifolia
Abronia fragrans
Acleisanthes wrightii
Allionia albida
Allioniella oxybaphoides
Anulocaulis leiosolenus
Boerhaavia viscosa
Boerhaavia wrightii
Selinocarpus angustifolius
Selinocarpus chenopodioides
Talinopsis frutescens
Odostemon trifoliolatus
Lesquerella argyrea
Lesquerella fendleri
Nerisyrenia camporum
Nerisyrenia linearifolia
Cowania ericaefolia
Fallugia paradoxa
Acacia berlandieri
Acacia constricta
Acacia greggii
Acuan velutina
Calliandra conferta
Leucaena pulverulenta
Leucaena retusa
Mimosa biuncifera
Mimosa borealis
Mimosa fragrans
Prosopis glandulosa
Strombocarpa pubescens
Cassia bauhinioides
Cassia pumilio
Cercidium texanum
Hoffmannseggia brachycarpa
Hoffmannseggia drepanocarpa
Hoffmannseggia jamesii
Hoffmannseggia oxycarpa
Krameria canescens
Krameria glandulosa
Krameria ramosissima
Krameria secundiflora
Eysenhardtia amorphoides
Parosela formosa
Parosela frutescens
Monoxalis dichondraefolia
Kallstroemia grandiflora
Covillea glutinosa
Porlieria angustifolia
Koeberlinia spinosa
Helietta parvifolia
Rutosma texanum
Aspicarpa longipes
Galphimia angustifolia
Castela nicholsonii
Bernardia myricaefolia
Mozinna spathulata
Trichosterigma antisyphilitica
Rhoeidium microphyllum
Rhus virens
Schaefferia cuneifolia
Condalia obovata
Condalia spathulata
Karwinskia humboldtiana
Microrhamnus ericoides
Zizyphus obtusifolius
Mortonia scabrella
Gayoides crispus
Malvastrum coccineum
Sida filipes
Sida hederacea
Sida neomexicana
Ayenia microrphylla
Ayenia pusilla
Hermannia texana
Fouquieria splendens
Amoreuxia wrightii
Ariocarpus fissuratus
Echinocactus brevihamatus
Echinocactus hamatacanthus
Echinocactus horizonthalonius
Echinocactus longihamatus
Echinocactus setispinus
Echinocactus texensis
Echinocactus wislizeni
Echinocereus caespitosus
Echinocereus dasyacanthus

Echinocereus dubius
Echinocereus enneacanthus
Echinocereus paucispinus
Echinocereus pectinatus
Echinocereus stramineus
Mamillaria heyderi
Mamillaria micromeris
Mamillaria pectinata
Mamillaria pusilla
Mamillaria scolymoides
Mamillaria vivipara
Opuntia arborescens
Opuntia arenaria
Opuntia engelmanni
Opuntia leptocaulis
Peniocereus greggii
Acrolasia albicaulis
Cevallia sinuata
Eucnide bartonioides
Nuttallia multiflora
Forestiera angustifolia
Menodora heterophylla
Macrosiphonia berlandieri
Gilia havardi
Gillia longiflora
Gilia multiflora
Marilaunidium hispidum
Coldenia canescens
Coldenia greggii
Coldenia hispidissima
Lippia ligustrina
Salvia ballotaeflora
Lycium pallidum
Quincula lobata
Leucophyllum minus
Leucophyllum texanum
Aciphyllaea acerosa
Baileya multiradiata
Chrystactinia mexicana
Flourensia cernua
Grindelia squarrosa
Laphamia angustifolia
Pectis angustifolia
Pectis longipes
Pectis papposa
Perezia nana
Perezia wrightii
Porophyllum gracile
Porophyllum scoparium
Sartwellia flaveriae
Tetraneuris scaposa
Thymophylla greggii
Thymophylla hartwegi
Thymophylla pentachaeta
Thymophylla thurberi
Trixis californica
Villanova dissecta
Zexmenia brevifolia

Birds here are comparatively numerous and the list of species is as follows:

Coragyps urubu urubu
Cathartes aura septentrionalis
Cerchneis sparveria sparveria
Cerchneis sparveria phalaena
Rhynchofalco fuscocoerulescens septentrionalis (R)
Planofalco mexicanus (R)
Buteo borealis calurus
Buteo albonotatus albonotatus
Buteo swainsoni
Haliaeetus leucocephalus leucocephalus (R)
Aquila chrysaetus canadensis
Accipiter cooperii (R)
Accipiter velox (R)
Circus cyaneus hudsonius (R)
Lophortyx gambelii gambelii
Callipepla squamata pallida
Colinus virginianus texanus
Chaemepelia passerina pallescens (R)
Scardafella inca (R)
Zenaidura macroura marginella
Geococcyx californianus
Centurus aurifrons (R)
Dryobates scalaris symplectus
Dryobates scalaris cactophilus
Speotyto cunicularia hypugaea
Bubo virginianus pallescens
Otus asio cineraceus
Phalaenoptilus nuttallii nuttallii
Chordeiles minor henryi

Chordeiles minor aserriensis
Chordeiles acutipennis texensis
Archilochus alexandri
Pyrocephalus rubinus mexicanus
Horizopus richardsonii richardsonii (R)
Myiarchus cinerascens cinerascens
Tyrannus verticalis
Tyrannus vociferans
Muscivora forficata
Otocoris alpestris leucolaema
Toxostoma crissalis
Toxostoma curvirostris curvirostris
Mimus polyglottos leucopterus
Polioptila melanura
Polioptila caerulea obscura
Salpinctes obsoletus obsoletus
Thryomanes bewickii cryptus
Thryomanes bewickii eremophilus
Heleodytes brunneicapillus couesi
Auriparus flaviceps flaviceps
Aphelocoma californica texana
Aphelocoma californica woodhouseii
Corvus cryptoleucus
Corvus corax sinuatus
Lanius ludovicianus exubitorides
Vireo bellii bellii
Vireo bellii medius
Vireo bellii arizonae
Hirundo rustica erythrogastris
Progne subis subis
Icteria virens longicauda
Sturnella neglecta neglecta
Xanthocephalus xanthocephalus
Icterus parisorum
Icterus cucullatus sennetti (R)
Icterus spurius
Euphagus cyanocephalus
Molothrus ater ater
Molothrus ater obscurus
Richmondena cardinalis canicauda
Pyrrhuloxia sinuata texana
Pyrrhuloxia sinuata sinuata
Guiraca caerulea lazula
Passerina versicolor versicolor
Passerina ciris pallidior
Passerina amoena
Pipilo fuscus mesoleucus
Spizella passerina arizonae
Amphispiza bilineata bilineata
Amphispiza bilineata deserticola
Peucaea cassinii
Aimophila ruficeps scottii
Aimophila ruficeps eremoeca
Pooecetes gramineus confinis
Chondestes grammacus strigatus
Carpodacus mexicanus frontalis
Astragalinus psaltria psaltria

Desert Grass Association.

The portions of the deserts, mesas, hills, and plains in central western Texas beyond the Devils and Pecos Rivers that have for their chief vegetation a covering, often more or less scanty, or grass, or that lack even this, are included in the present area. In addition to grasses, the only plants present are a few herbaceous species and cactuses. The number of birds is not large, and consists chiefly of desert forms, mostly those that are attracted by open land or grassy areas. As compared with either the Desert Chaparral or Desert Riparian associations the effect of the difference in vegetation on the bird life is very marked.

The plants found here are principally as follows:

Andropogon cirrhatus *Andropogon hirtiflorus*

Aristida arizonica
Aristida bromoides
Aristida divaricata
Aristida fendleriana
Aristida nealleyi
Aristida purpurea
Bouteloua aristidoides
Bouteloua breviseta
Bouteloua chondrosioides
Bouteloua eriopoda
Bouteloua gracilis
Bouteloua hirsuta
Bouteloua uniflora
Cathestecum erectum
Elyonurus barbiculmis
Elyonurus tripsacoides
Epicampes rigens
Epicampes stricta
Eragrostis lugens
Eriochloa punctata
Heteropogon contortus
Hilaria cenchroides
Hilaria jamesii
Hilaria mutica
Lycurus phleoides
Muhlenbergia arenicola
Muhlenbergia berlandieri
Muhlenbergia capillaris rigida
Muhlenbergia depauperata
Muhlenbergia monticola
Muhlenbergia parviglumis
Muhlenbergia porteri
Panicum arizonicum
Panicum hallii
Panicum hirticaule
Panicum huachucae
Panicum obtusum
Panicum reverchoni
Pappophorum vaginatum
Pappophorum wrightii
Poa bigelovii
Sphenopholis interrupta
Sporobolus auriculatus
Sporobolus buckleyi
Sporobolus confusus
Sporobolus flexuosus
Sporobolus texanus
Sporobolus wrightii
Stipa emineus
Trachypogon mountufari
Thichloris mendocina
Tridens albescens
Tridens avenaceus
Tridens muticus
Tridens pilosus
Tridens pulchellus
Tridens texanus
Abronia angustifolia
Selinocarpus angustifolius
Argemone platyceras
Nerisyrenia camporum
Sida diffusa
Sida physocalyx
Raimannia heterophylla
Echinocactus texensis
Echinocereus caespitosus
Echinocereus enneacanthus
Echinocereus stramineus
Mamillaria heyderi
Mamillaria vivipara
Marilaunidium hispidum
Verbena bipinnatifida
Verbena bracteosa
Verbena canescens
Verbena ciliata
Verbena hastata
Castilleja integra
Castilleja lanata
Castilleja sessiliflora
Baileya multiradiata
Hymenoxys odorata
Porophyllum gracile
Ratibida columnifera
Thymophylla polychaeta

The birds are:

Coragyps urubu urubu
Cathartes aura septentrionalis
Cerchneis sparveria sparveria
Cerchneis sparveria phalaena
Planofalco mexicanus (R)
Buteo borealis calurus
Buteo albonotatus albonotatus
Buteo swainsoni

Haliaeetus leucocephalus leucocephalus (R)
Aquila chrysaetos canadensis
Accipiter cooperii (R)
Accipiter velox (R)
Circus cyaneus hudsonius (R)
Callipepla squamata pallida
Oxyechus vociferus vociferus
Zenaidura macroura marginella
Speotyto cunicularia hypugaea
Chordeiles minor henryi
Chordeiles minor aserriensis
Chordeiles acutipennis texensis
Aeronautes saxatalis
Otocoris alpestris leucolaema
Salpinctes obsoletus obsoletus
Corvus cryptoleucus
Corvus corax sinuatus
Lanius ludovicianus excubitoroides
Phainopepla nitens
Hirundo rustica erythrogastris
Progne subis subis
Sturnella magna hoopesi
Xanthocephalus xanthocephalus
Euphagus cyanocephalus
Molothrus ater ater
Molothrus ater obscurus
Ammodramus savannarum bimaculatus
Pooecetes gramineus confinis
Chondestes grammacus strigatus
Passer domesticus domesticus

Desert Riparian Association.

The canyons, narrow stream valleys, and isolated springs of the desert region of western Texas, beyond the Devils and Pecos Rivers, make up the present association. Here the contrast between the arid mesas and plains of the upland and the moist valleys is most marked, and both flora and fauna reflect this great difference. The canyons and valleys support a variety of plant life, for in addition to many of the characteristic species of the mesas there grow here many moisture loving trees and shrubs. A more or less dense low chaparral usually covers the sides of these canyons and valleys; while thickets of more hydrophilous shrubs, and in many cases an arboreal growth of considerable height occupy their bottoms along the streams. About the isolated springs on the upland or in the plain-like broad valleys there usually spring up clumps of trees, chiefly *Populus monilifera*. As might be expected, this kind of environment, particularly in view of the absence of such vegetation from most of the surrounding desert, proves very attractive to birds that live in trees or bushes; and this is, in fact, one of the very best ornithological grounds in the entire State.

The character of the vegetation may be judged from the following list of plants:

Selaginella lepidophylla
Juniperus sabinoides (R)
Ephedra antisyphilitica
Ephedra nevadensis
Typha latifolia
Arundinaria macrosperma

Dasylirion texanum
Hesperaloe parvifolia
Yucca macrocarpa
Smilax bonanox
Populus deltoides
Salix nigra
Hicoria pecan (R)
Juglans rupestris
Quercus undulata
Quercus virginiana (R)
Celtis occidentalis
Celtis reticulata
Momisia pallida
Morus rubra
Eriogonum jamesii
Eriogonum rotundifolium
Eriogonum tenellum
Eriogonum trichopodum
Eriogonum wrightii
Atriplex canescens
Anulocaulis leiosolenus
Boerhaavia bracteosa
Boerhaavia purpurascens
Boerhaavia torreyana
Boerhaavia viscosa
Commicarpus scandens
Selinocarpus chenopodioides
Selinocarpus diffusus
Phytolacca americana
Clematis drummondii
Viorna pitcheri
Viorna reticulata
Odostemon trifoliolatus
Argemone platyceras
Arabis ludoviciana
Arabis petiolaris
Bursa pubens
Draba cuneifolia
Lepidium alyssoides
Lepidium intermedium
Radicula obtusa
Radicula palustris
Streptanthus carinatus
Platanus occidentalis
Fallugia paradoxa
Rosa fendleri
Acacia constricta
Acacia roemeriana
Acacia schottii
Leucaena pulverulenta
Leucaena retusa
Mimosa borealis
Prosopis glandulosa
Strombocarpa pubescens
Vachellia farnesiana
Cercis occidentalis
Hoffmannseggia densiflora
Broussonetia secundiflora
Eysenhardtia amorphoides
Glycyrrhiza lepidota
Parosela frutescens
Parosela scoparia
Covillea glutinosa
Guaiacum sanctum
Porlieria angustifolia
Koeberlinia spinosa
Ptelea mollis
Aspicarpa hyssopifolia
Bernardia myricaefolia
Croton torryeanus
Mozinna spathulata
Pistacia mexicana
Rhoeidium microphyllum
Rhus virens
Toxicodendron radicans
Colubrina texensis
Condalia spathulata
Karwinskia humboldtiana
Rhamnus caroliniana
Zizyphus obtusifolius
Mortonia scabrella
Sapindus drummondii
Ungnadia speciosa
Vitis arizonica
Vitis candicans
Vitis riparia
Vitis rupestris
Hermannia texana
Fouquieria splendens
Ariocarpus fissuratus
Echinocactus brevihamatus
Echinocactus hamatacanthus
Echinocactus horizonthalonius
Echinocactus longihamatus
Echinocereus enneacanthus
Echinocereus paucispinus

Echinocereus stramineus
Mamillaria echinus
Mamillaria heyderi
Opuntia engelmanni
Opuntia grahami
Opuntia leptocaulis
Peniocereus greggii
Oenothera jamesii
Brayodendron texanum
Forestiera angustifolia
Fraxinus greggii
Gilia incisa
Phlox drummondii
Lippia lingustrina
Salvia chamaedryoides
Lycium berlandieri
Nicotiana glauca
Physalis lanceolata
Castilleja lanata
Leucophyllum texanum
Ruellia tuberosa
Chilopsis linearis
Stenolobium stans
Cephalanthus occidentalis
Apodanthera undulata
Cucurbita foetidissima
Ibervillea lindheimeri
Ibervillea tenuisecta
Xanthium canadense
Baccharis bigelovii
Baccharis glutinosa
Baccharis salicina
Bahia bigelovii
Cirsium wrightii
Grindelia squarrosa
Laphamia bisetosa
Perezia wrightii
Perityle parryi
Porophyllum macrocephalum
Trixis californica

Its long list of birds is as follows:

Nyctanassa violacea (R)
Butorides virescens virescens (R)
Ardea herodias treganzai (R)
Spatula clypeata (R)
Querquedula cyanoptera (R)
Querquedula discors
Coragyps urubu urubu
Cathartes aura septentrionalis
Cerchneis sparveria sparveria
Cerchneis sparveria phalaena
Rhynchofalco fuscocoerulescens septentrionalis (R)
Planofalco mexicanus (R)
Buteo borealis calurus
Buteo albonotatus albonotatus
Buteo swainsoni
Haliaeetus leucocephalus leucocephalus (R)
Aquila chrysaetos canadensis
Accipiter cooperii (R)
Accipiter velox (R)
Circus cyaneus hudsonius (R)
Pandion haliaetus carolinensis (R)
Meleagris gallopavo intermedia (R)
Callipepla squamata pallida
Colinus virginianus texanus
Fulica americana (R)
Oxyechus vociferus vociferus
Actitis macularia (R)
Chaemepelia passerina pallescens (R)
Zenaidura macroura marginella
Geococcyx californianus
Coccyzus americanus occidentalis
Colaptes cafer collaris
Centurus aurifrons (R)
Dryobates scalaris symplectus
Dryobates scalaris cactophilus
Chloroceryle americana septentrionalis
Streptoceryle alcyon alcyon
Bubo virginianus pallescens
Otus asio cineraceus
Phalaenoptilus nuttallii nuttallii
Chordeiles minor henryi
Chordeiles minor aserriensis
Chordeiles acutipennis texensis
Archilochus alexandri
Aeronautes saxatalis
Pyrocephalus rubinus mexicanus
Empidonax traillii brewsteri

Horizopus richardsonii richardsonii
Sayornis sayus
Sayornis nigricans semiater
Myiarchus cinerascens cinerascens
Tyrannus verticalis
Tyrannus vociferans
Muscivora forficata
Toxostoma crissalis
Toxostoma curvirostris curvirostris
Mimus polyglottos leucopterus
Polioptila melanura
Polioptila caerulea obscura
Catherpes mexicanus polioptilus
Catherpes mexicanus albifrons
Salpinctes obsoletus obsoletus
Thryomanes bewickii eremophilus
Thryothorus ludovicianus ludovicianus
Heleodytes brunneicapillus couesi
Psaltriparus plumbeus plumbeus
Psaltriparus melanotis lloydi
Auriparus flaviceps flaviceps
Aphelocoma californica texana
Aphelocoma californica woodhouseii
Corvus cryptoleucus
Corvus corax sinuatus
Lanius ludovicianus excubitorides
Vireo bellii bellii
Vireo bellii medius
Vireo bellii arizonae
Vireo atricapillus
Lanivireo solitarius plumbeus
Vireosylva gilva swainsonii
Vireosylva olivacea
Phainopepla nitens
Hirundo rustica erythrogastris
Riparia riparia riparia
Stelgidopteryx serripennis serripennis
Petrochelidon albifrons tachina
Progne subis subis
Icteria virens longicauda
Geothlypis trichas occidentalis
Dendroica aestiva sonorana
Xanthocephalus xanthocephalus
Agelaius phoeniceus neutralis
Icterus bullocki bullockii
Icterus parisorum
Icterus cucullatus sennetti (R)
Icterus spurius
Euphagus cyanocephalus
Molothrus ater ater
Molothrus ater obscurus
Piranga rubra rubra
Piranga rubra cooperi
Richmondena cardinalis canicauda
Pyrrhuloxia sinuata texana
Pyrrhuloxia sinuata sinuata
Guiraca caerulea lazula
Passerina versicolor versicolor
Passerina ciris pallidior
Passerina amoena
Pipilo fuscus mesoleucus
Spizella passerina arizonae
Amphispiza bilineata bilineata
Amphispiza bilineata deserticola
Peucaea cassinii
Aimophila ruficeps scottii
Aimophila ruficeps eremoeca
Pooecetes gramineus confinis
Chondestes grammacus strigatus
Carpodacus mexicanus frontalis
Astragalinus psaltria psaltria

Alkali Association.

This comprises the bare alkali flats of the desert region west of the Pecos River, where both vegetable and animal life are reduced to a minimum. About the only vegetation is salt grass, but a few other low halophilous plants grow, chiefly about the margins of these hard, sun-baked plains. As a consequence chiefly of the lack of vegetation, this area offers little or no attraction to bird life; and the smallness

of the number of species that occur here bears eloquent tribute to the effect of vegetation on the avifauna.

The principal plants are:

Distichlis spicata
Allenrolfea occidentalis
Atriplex expansa
Dondia depressa
Dondia suffrutescens
Monolepis nuttalliana
Salicornia perennis

The only birds frequenting this area are:

Cathartes aura septentrionalis
Accipiter cooperii (R)
Accipiter velox (R)
Oxyechus vociferus vociferus
Chordeiles minor henryi
Otocoris alpestris leucolaema
Corvus cryptoleucus
Corvus corax sinuatus
Amphispiza bilineata bilineata
Peucaea cassinii

Mountain Chaparral Association.

This comprises the chaparral on the lower slopes and in the canyons of the mountains in central western Texas, beyond the Pecos River, and extends to an altitude of some 5000 to 6000 feet, in places somewhat higher. In general character it does not differ from the chaparral of the more level desert country, but is of somewhat different composition, with fewer cactuses and yuccas and an infusion of mountain forms. The bird life, too, shows the effect of the proximity of the vegetation of the higher mountain altitudes.

The principal plants are as follows:

Selaginella lepidophylla
Aristida nealleyi
Bouteloua breviseta
Bouteloua chondrosioides
Bouteloua curtipendula
Bouteloua eriopoda
Bouteloua gracilis
Bouteloua parryi
Bouteloua ramosa
Melica porteri
Muhlenbergia arenicola
Muhlenbergia berlandieri
Muhlenbergia capillaris
Muhlenbergia monticola
Muhlenbergia repens rigida
Panicum hallii
Panicum havardii
Dasylirion texanum
Nolina microcarpa
Yucca baccata
Yucca elata
Agave applanata
Agave lechuguilla
Agave wislizeni
Salix nigra
Celtis reticulata
Momisia pallida
Aristolochia brevipes
Eriogonum abertianum
Eriogonum annuum
Eriogonum havardi
Eriogonum microthecum
Eriogonum rotundifolium
Eriogonum suffruticosum
Eriogonum wrightii
Boerhaavia anisophylla
Boerhaavia erecta
Boerhaavia viscosa

Boerhaavia wrightii
Odostemon trifoliolatus
Fallugia paradoxa
Prunus minutiflora
Acacia constricta
Mimosa biuncifera
Mimosa flexuosa
Prosopis glandulosa
Hoffmannseggia densiflora
Hoffmannseggia melanosticta
Krameria canescens
Broussonetia secundiflora
Eysenhardtia amorphoides
Parosela argyraea
Parosela jamesii
Parosela lachnostachys
Parosela wrightii
Koeberlinia spinosa
Porlieria angustifolia
Rutosma texanum
Chamaesyce polycarpa
Chamaesyce villifera
Croton lindheimerianus
Ditaxis humilis
Mozinna spathulata
Tithymalus campestris
Tithymalus chamaesula
Tithymalus montanus
Rhoeidium microphyllum
Rhus virens
Schmaltzia trilobata
Ceanothus greggii
Zizyphus obtusifolius
Ungnadia speciosa
Fouquieria splendens
Echinocactus horizonthalonius
Echinocactus intertextus
Echinocactus longihamatus
Echinocereus dasyacanthus
Echinocereus stramineus
Mamillaria grahami
Mamillaria meiacantha
Mamillaria micromeris
Mamillaria vivipara
Opuntia arborescens
Opuntia engelmanni
Opuntia kleiniae
Opuntia leptocaulis
Brayodendron texanum
Forestiera angustifolia
Macrosiphonia wrightii
Lippia ligustrina
Salvia regla
Lycium berlandieri
Leucophyllum minus
Leucophyllum texanum
Pentsteman barbatus
Pentstemon havardi
Chilopsis linearis
Stenolobium stans
Pectis filipes
Perityle vaseyi

The birds in this area are included in the following list:

Cathartes aura septentrionalis
Cerchneis sparveria phalaena
Rhynchodon peregrinus anatum (R)
Planifalco mexicanus (R)
Buteo borealis calurus
Buteo albonotatus albonotatus
Buteo swainsoni
Aquila chrysaetos canadensis
Accipiter cooperii (R)
Accipiter velox (R)
Cyrtonyx montezumae mearnsi
Callipepla squamata pallida
Zenaidura macroura marginella
Chloroenas fasciata fasciata
Geococcyx californianus
Dryobates scalaris cactophilus
Bubo virginianus pallescens
Otus asio cineraceus
Phalaenoptilus nuttallii nuttallii
Chordeiles minor henryi
Chordeiles acutipennis texensis
Calothorax lucifer
Archilochus alexandri
Selasphorus platycercus
Aeronautes saxatalis
Horizopus richardsonii richardsonii (R)
Empidonax wrightii
Sayornis sayus

Sayornis nigricans semiater
Myiarchus cinerascens cinerascens
Tyrannus vociferans
Toxostoma curvirostris curvirostris
Mimus polyglottos leucopterus
Polioptila melanura
Polioptila caerulea obscura
Catherpes mexicanus polioptilus
Salpinctes obsoletus obsoletus
Thryomanes bewickii eremophilus
Heleodytes brunneicapillus couesi
Psaltriparus plumbeus
Psaltriparus melanotis lloydi
Auriparus flaviceps flaviceps
Aphelocoma californica texana
Aphelocoma californica woodhouseii
Corvus cryptoleucus
Corvus corax sinuatus
Lanius ludovicianus excubitorides
Hirundo rustica erythrogastris
Icteria virens longicauda
Xanthocephalus xanthocephalus (R)
Icterus parisorum
Icterus spurius
Molothrus ater ater
Guiraca caerulea lazula
Passerina versicolor versicolor (R)
Passerina ciris pallidior
Pipilo fuscus mesoleucus
Pipilo maculatus montanus
Oberholseria chlorura (R)
Spizella passerina arizonae
Amphispiza bilineata deserticola
Peucaea cassinii
Aimophila ruficeps scottii
Aimophila ruficeps eremoeca
Chondestes grammacus strigatus
Carpodacus mexicanus frontalis
Astragalinus psaltria psaltria

Mountain Oak Association.

The deciduous forests of the middle slopes and canyons of the high mountains in central western Texas, beyond the Pecos River, form a fairly well defined association. These forests are rather low, but well cover the ground, and in many places have considerable underbrush. Oaks of several species form the dominating element, though various other deciduous trees constitute a considerable admixture. The characteristic birds are forest species, some of them peculiar to the mountains.

The principal plants are:

Pinus edulis (R)
Juniperus flaccida (R)
Juniperus monosperma (R)
Allium scaposum
Nolina microcarpa
Yucca baccata
Agave applanata
Agave wislizeni
Salix irrorata
Salix wrightii
Juglans rupestris
Quercus emoryi
Quercus fendleri
Quercus grisea
Quercus hypoleuca
Quercus muhlenbergii
Quercus novomexicana
Quercus oblongifolia
Quercus texana
Quercus undulata
Celtis reticulata
Morus microphylla
Eriogonum abertianum
Eriogonum rotundifolium
Eriogonum wrightii
Mirabilis wrightiana

Quamoclidion multiflorum
Aquilegia chrysantha
Aquilegia longissima
Clematis drummondii
Odostemon haematocarpus
Odostemon repens
Heuchera rubescens
Philadelphus microphyllus
Cercocarpus montanus
Fallugia paradoxa
Rosa arkansana
Padus acutifolia
Padus salicifolia
Cercis occidentalis
Mimosa biuncifera
Linum greggii
Linum rigidum
Ionoxalis violacea
Ptelea angustifolia
Ptelea mollis
Rutosma texanum
Polygala puberula
Polygala scoparia
Tithymalus campestris
Tithymalus chamaesula
Tithymalus montanus
Schmaltzia trilobata
Toxicodendron toxicodendron
Adolphia infesta
Ceanothus greggii
Rhamnus purshiana
Rhamnus tomentella
Sapindus drummondii
Vitus rupestris
Garrya lindheimeri
Garrya wrightii
Arbutus texana
Fraxinus berlandieri
Fraxinus cuspidata
Fraxinus greggii
Fraxinus pistaciaefolia
Gilia texana
Phlox drummondii
Salvia regla
Castilleja lanata
Pentstemon barbatus
Pentstemon cyananthus
Pentstemon havardi
Chilopsis linearis
Lonicera albiflora
Symphoricarpos longiflorus
Symphoricarpos rotundifolius
Artemisia frigida
Artemisia redolens
Berlandiera lyrata
Perityle vaseyi

The birds of this area are:

Cathartes aura septentrionalis
Cerchneis sparveria phalaena
Planofalco mexicanus (R)
Buteo borealis calurus
Buteo albonotatus albonotatus
Buteo swainsoni
Aquila chrysaetos canadensis
Accipiter cooperii (R)
Accipiter velox (R)
Meleagris gallopavo merriami (R)
Cyrtonyx montezumae mearnsi
Zenaidura macroura marginella
Chloroenas fasciata fasciata
Geococcyx californianus
Coccyzus americanus occidentalis
Colaptes cafer collaris
Balanosphyra formicivora formicivora
Balanosphyra formicivora aculeata
Dryobates scalaris cactophilus
Bubo virginianus pallescens
Otus asio cineraceus
Otus flammeolus (R)
Setochalcis vocifera arizonae
Cyanolaemus clemenciae bessophilus
Calothorax lucifer
Archilochus alexandri
Selasphorus platycercus
Aeronautes saxatalis
Nuttallornis borealis majorinus (R)
Horizopus richardsonii richardsonii
Empidonax wrightii

Sayornis sayus
Sayornis nigricans semiater
Myiarchus cinerascens cinerascens
Tyrannus vociferans
Sialia mexicana bairdi (R)
Turdus migratorius propinquus (R)
Polioptila melanura
Polioptila caerulea obscura
Catherpes mexicanus polioptilus
Salpinctes obsoletus obsoletus
Thryomanes bewickii eremophilus
Sitta carolinensis nelsoni
Psaltriparus plumbeus plumbeus
Psaltriparus melanotis lloydi
Penthestes gambeli gambeli
Baeolophus inornatus griseus
Baeolophus atricristatus atricristatus
Cyanocitta stelleri macrolopha
Aphelocoma sieberii couchii
Aphelocoma californica texana
Aphelocoma californica woodhouseii
Corvus corax sinuatus
Lanius ludovicianus excubitoroides
Vireo huttoni stephensi
Lanivireo solitarius plumbeus
Vireosylva olivacea (R)
Icterus parisorum
Icterus spurius
Piranga ludoviciana (R)
Piranga hepatica oreophasma (R)
Piranga rubra cooperi
Hedymeles melanocephalus papago
Pipilo fuscus mesoleucus
Pipilo maculatus montanus
Spizella passerina arizonae
Amphispiza bilineata deserticola
Aimophila ruficeps scottii
Aimophila ruficeps eremoeca
Carpodacus mexicanus frontalis
Astragalinus psaltria psaltria

Mountain Pinyon Association.

The portions of the middle and upper slopes of the Texas mountains, west of the Pecos River, that are covered by juniper and pinyon timber are included in this area.

While the forest has much the same general character as in the Mountain Osk Association, the dominant place of the oaks in that area is taken by the pinyons and junipers, chiefly *Pinus edulis*, *Pinus cembroides*, *Juniperus pachyphloea*, *Juniperus monosperma*, and *Juniperus sabinoides*. The stand of pinyon and juniper is in places almost pure, but in many others has a considerable admixture of oaks and similar deciduous trees.

The principal elements of the vegetation are disclosed by the following list:

Pinus cembroides
Pinus edulis
Juniperus flaccida
Juniperus monosperma
Juniperus pachyphloea
Juniperus sabinoides
Juniperus scopulorum
Allium scaposum
Nolina microcarpa
Salix irrorata
Salix wrightii
Quercus emoryi
Quercus fendleri
Quercus grisea
Quercus novomexicana
Juglans rupestris

Celtis reticulata
Morus microphylla
Phoradendron bolleanum
Eriogonum abertianum
Eriogonum rotundifolium
Eriogonum wrightii
Mirabilis wrightiana
Quamoclidion multiflorum
Aquilegia chrysantha
Aquilegia longissima
Clematis drummondii
Odostemon fremonti
Odostemon repens
Heuchera rubescens
Philadelphus microphyllus
Cercocarpus montanus
Fallugia paradoxa
Rosa arkansana
Padus acutifolia
Padus salicifolia
Cercis occidentalis
Linum greggii
Linum rigidum
Ionoxalis violacea
Ptelea angustifolia
Ptelea mollis
Rutosma texanum
Polygala puberula
Polygala scoparia
Tithymalus campestris
Tithymalus chaemesula
Tithymalus montanus
Schmaltzia trilobata
Toxicodendron toxicodendron
Adolphia infesta
Ceanothus greggii
Rhamnus purshiana
Rhamnus tomentella
Vitis rupestris
Garrya lindheimeri
Garrya wrightii
Arbutus texana
Fraxinus berlandieri
Fraxinus cuspidata
Fraxinus greggii
Fraxinus pistaciaefolia
Gilia texana
Phlox drummondii
Salvia regla
Castilleja lanata
Pentstemon barbatus
Pentstemon cyananthus
Pentstemon havardi
Lonicera albiflora
Symphoricarpos longiflorus
Symphoricarpos rotundifolius
Artemisia frigida
Artemisia redolens
Berlandiera lyrata
Perityle vaseyi

The birds frequenting this association are:

Cathartes aura septentrionalis
Cerchneis sparveria phalaena
Buteo borealis calurus
Buteo albonotatus albonotatus
Buteo swainsoni
Aquila chrysaetos canadensis
Accipiter cooperii (R)
Accipiter velox (R)
Meleagris gallopavo merriami (R)
Cyrtonyx montezumae mearnsi
Zenaidura macroura marginella
Chloroenas fasciata fasciata
Colaptes cafer collaris
Balanosphyra formicivora formicivora
Balanosphyra formicivora aculeata
Sphyrapicus varius nuchalis (R)
Dryobates scalaris cactophilus
Dryobates villosus leucothorectis
Bubo virginianus pallescens
Otus asio cineraceus
Otus flammeolus (R)
Setochalcis vocifera arizonae
Cyanolaemus clemenciae bessophilus
Archilochus alexandri
Selasphorus platycercus
Aeronautes saxatalis
Nuttallornis borealis majorinus (R)
Myiarchus cinerascens cinerascens

Horizopus richardsonii richardsonii
Tyrannus vociferans
Sialia mexicana bairdi
Turdus migratorius propinquus (R)
Polioptila melanura
Polioptila caerulea obscura
Salpinctes obsoletus obsoletus
Thryomanes bewickii eremophilus
Sitta pygmaea pygmaea
Sitta carolinensis nelsoni
Psaltriparus plumbeus plumbeus
Psaltriparus melanotis lloydi
Penthestes gambeli gambeli
Baeolophus inornatus griseus
Baeolophus atricristatus ctristatus
Cyanocitta stelleri macrolopha
Aphelocoma sieberii couchii
Aphelocoma californica texana
Aphelocoma californica woodhouseii
Cyanocephalus cyanocephalus
Corvus corax sinuatus
Lanius ludovicianus excubitorides
Vireo huttoni stephensi
Lanivireo solitarius plumbeus
Dendroica auduboni memorabilis
Piranga ludoviciana (R)
Piranga hepatica oreophasma
Piranga rubra cooperi
Hedymeles melanocephalus papago
Pipilo maculatus montanus
Spizella passerina arizonae
Junco dorsalis
Aimophila ruficeps scottii
Aimophila ruficeps eremoeca

Mountain Pine and Spruce Association.

This comprises the somewhat limited areas along the upper slopes and in the higher canyons of the western Texas mountains, beyond the Pecos River, where the dominating arboreal vegetation consists of pine, spruce, and cypress. These trees form in many places a tall forest with practically no undergrowth. Elsewhere, particularly in the canyons, there is a considerable mixture of deciduous trees with some underbrush. The characteristic birds are mostly mountain species of the coniferous forest.

The principal plants are as follows:

Pinus brachyptera
Pinus flexilis
Pseudotsuga mucronata
Cupressus arizonica
Populus aurea
Salix irrorata
Ostrya baileyi
Quercus emoryi
Quercus fendleri
Quercus grisea
Quercus leucophylla
Quercus muhlenbergii
Quercus novomexicana
Quercus texana
Quercus undulata
Aquilegia chrysantha
Aquilegia longissima
Odostemon repens
Heuchera rubescens
Philadelphus microphyllus
Cercocarpus montanus
Rosa arkansana
Sericotheca dumosa
Amelanchier alnifolia
Padus acutifolia
Cercis occidentalis
Robinia neomexicana
Linum lewisii
Ionoxalis violacea
Ptelea mollis

Polygala scoparia
Schmaltzia trilobata
Toxicodendron toxicodendron
Ceanothus greggii
Rhamnus purshiana
Acer grandidentatum
Vitis rupestris
Garrya lindheimeri
Arbutus texana (R)
Fraxinus greggii
Fraxinus viridis
Gilia texana
Solanum fendleri
Castilleja lanata
Lonicera albiflora
Symphoricarpos longiflorus
Campanula petiolata

The birds frequenting this association are as follows:

Cathartes aura septentrionalis
Cerchneis sparveria phalaena
Buteo borealis calurus
Buteo albonotatus albonotatus
Buteo swainsoni
Aquila chrysaetos canadensis
Accipiter cooperii (R)
Accipiter velox (R)
Meleagris gallopavo merriami (R)
Cyrtonyx montezumae mearnsi
Chloroenas fasciata fasciata
Colaptes cafer collaris
Balanosphyra formicivora formicivora
Balanosphyra formicivora aculeata
Sphyrapicus varius nuchalis (R)
Dryobates villosus leucothorectis
Bubo virginianus pallescens
Otus asio cineraceus
Otus flammeolus (R)
Strix occidentalis lucida (R)
Setochalcis vocifera arizonae
Cyanolaemus clemenciae bessophilus
Selasphorus platycercus
Aeronautes saxatalis
Nuttallornis borealis majorinus (R)
Horizopus richardsonii richardsonii
Empidonax difficilis difficilis
Tyrannus vociferans (R)
Sialia mexicana bairdi
Turdus migratorius propinquus (R)
Salpinctes obsoletus obsoletus
Thryomanes bewickii eremophilus
Sitta pygmaea pygmaea
Sitta carolinensis nelsoni
Psaltriparus plumbeus plumbeus
Psaltriparus melanotis lloydi
Penthestes gambeli gambeli
Cyanocitta stelleri macrolopha
Apheloeoma sieberii couchii
Corvus corax sinuatus
Vireo huttoni stephensi
Lanivireo solitarius plumbeus
Dendroica auduboni memorabilis
Piranga ludoviciana (R)
Piranga hepatica oreophasma
Hedymeles melanocephalus papago
Pipilo maculatus montanus
Junco dorsalis
Loxia curvirostra stricklandi (R)

Mountain Grass Association.

This comprises the open grassy valleys, which the grassy slopes and meadows on the middle and upper portions of the mountains in central western Texas, beyond the Pecos River, mostly above an altitude of 5500 feet. In addition to the more or less luxuriant carpet of grasses, the vegetation consists of various flowering herbaceous plants, with scattered

individuals of *Agave wislizeni*, *Agave applanata*, *Yucca baccata*, and *Nolina microcarpa*.

The principal plants are as follows:

Aristida bromoides
Aristida schiediana
Blepharoneuron tricholepis
Bouteloua aristidoides
Bouteloua curtipendula
Bouteloua gracilis
Bouteloua parryi
Bouteloua racemosa
Bouteloua texana
Cottea pappophoroides
Eragrostis limbata
Melica porteri
Muhlenbergia texensis
Muhlenbergia ligulata
Muhlenbergia pauciflora
Muhlenbergia repens
Muhlenbergia setifolia
Muhlenbergia trifida
Oryzopsis fimbriata
Oryzopsis hymenoides
Panicum hallii
Panicum havardii
Poa bigelovii
Stipa eminens
Stipa neomexicana
Stipa pringlei
Stipa tenuissima
Stipa viridula
Trichloris mendocina
Allium palmeri
Allium scaposum
Nolina microcarpa
Yucca baccata
Agave applanata
Agave wislizeni
Eriogonum abertianum
Eriogonum annuum
Eriogonum microthecum
Eriogonum wrightii
Eurotia lanata
Mirabilis longiflora
Quamoclidion multiflorum
Aquilegia chrysantha
Aquilegia longissima
Linum greggii
Linum lewisii
Rutosma texanum
Polygala scoparia
Chamaesyce villifera
Tithymalus campestris
Tithymalus montanus
Gilia longiflora
Gilia texana
Phlox drummondii
Salvia regla
Castilleja lanata
Castilleja lindheimeri
Pentstemon barbatus
Pentstemon cyananthus
Pentstemon havardi
Cucurbita foetidissima
Artemisia frigida
Bahia bigelovii
Berlandiera lyrata
Centaurea americana
Chrysothamnus pulcnellus
Grindelia squarrosa
Helianthus annuus
Pectis filipes
Pertityle vaseyi
Solidago bigelovii

The birds found here are:

Cathartes aura septentrionalis
Cerchneis sparveria phalaena
Rhynchodon peregrinus anatum (R)
Planofalco mexicanus (R)
Buteo borealis calurus
Buteo swainsoni
Aquila chrysaetos canadensis
Accipiter cooperii (R)
Accipiter velox (R)
Meleagris gallopavo merriami(R)
Curtonyx montezumae mearnsi

Callipepla squamata pallida
Oxyechus vociferus vociferus
Zenaidura macroura marginella
Chloroenas fasciata fasciata
Geococcyx californianus
Chordeiles minor henryi
Cyanolaemus clemenciae bessophilus
Calothorax lucifer
Archilochus alexandri
Selasphorus platycercus
Aeronautes saxatalis
Turdus migratorius propinquus (R)
Corvus corax sinuatus
Lanius ludovicianus excubitorides
Progne subis subis
Xanthocephalus xanthocephalus
Molothrus ater ater
Pipilo fuscus mesoleucus
Spizella passerina arizonae
Aimophila ruficeps scottii
Aimophila ruficeps eremoeca
Chondestes grammacus strigatus

Mountain Mural Association.

This association is made up of the bare rock slopes, cliffs, and canyons of the mountains in the trans-Pecos region of central western Texas. Here and there a little grass, a rock plant or stunted shrub constitute the only vegetation. This absence of plant life is largely responsible for the very small bird fauna found here.

The chief plants are included in the following list:

Cheilanthes tomentosa
Cheilanthes wrightii
Gymnogramme ehrenbergiana
Notholaena schaffneri
Notholaena standleyi
Pellaea aspera
Selaginella lepidophylla
Selaginella pringlei
Ephedra trifurca
Aristida nealleyi
Cottea pappophoroides
Melica nitens
Muhlenbergia gracillima
Muhlenbergia repens
Panicum havardi
Scleropogon brevifolius
Stipa neomexicana
Cotyledon strictiflora
Sedum liebmannianum
Sedum wrightii
Heuchera rubescens
Cercocarpus montanus
Amelanchier alnifolia
Ceanothus greggii
Ariocarpus fissuratus
Garrya lindheimeri
Nama origanifolium

The birds, also few in number, are as follows:

Cathartes aura septentrionalis
Cerchneis sparveria phalaena
Rhynchodon peregrinus anatum (R)
Planofalco mexicanus (R)
Buteo borealis calurus
Buteo albonotatus albonotatus
Buteo swainsoni
Aquila chrysaetos canadensis
Accipiter cooperii (R)
Accipiter velox (R)
Callipepla squamata pallida
Bubo virginianus pallescens
Chordeiles minor henryi
Aeronautes saxatalis
Sayornis sayus
Sayornis nigricans semiater
Catherpes mexicanus polioptilus

Salpinctes obsoletus obsoletus
Thryomanes bewickii eremophilus (R)
Corvus corax sinuatus
Lanius ludovicianus excubitorides
Progne subis subis
Pipilo fuscus mesoleucus
Aimophila ruficeps scottii
Aimophila ruficeps eremoeca
Carpodacus mexicanus frontalis

CHANGES IN THE BIRD LIFE OF TEXAS.

Changes in Vegetation.

It is, of course, evident that the vegetation of any given area is continually undergoing change. Since these changes more or less vitally, according to their character, affect the dependent bird life, it is of importance to consider briefly the causes of such plant changes.

Plants, under favorable circumstances, tend to increase their geographical range up to the limit of territory suitable for their existence. This is often prevented, however, by extraneous causes, such as natural or artificial barriers and accidents. Among the natural mechanical barriers to the extension of the distribution of plant species may be mentioned oceans and other large bodies of water; swift, deep streams; bare deserts; high, rocky mountain ranges, and the lack of soil. The physiological barriers which determine the area in which a given species of plant may find suitable environment, and by which, of course, its permanent existence is limited, are chiefly temperature, humidity, moisture, light, evaporation, and the character of soil. Of these, temperature and humidity are undoubtedly the most fundamental, as a study of the western deserts clearly shows.

Among the destructive causes which operate to change vegetation may be mentioned the sudden increase in the numbers of destructive insects, which, thereupon, ravage the trees of the forests and other plants, and often lead to practical extermination of the species over considerable areas, which disappearance may be temporary or permanent, according to circumstances. Of the insects, the great increase of which nearly always proves menace to vegetation, may be mentioned the grasshopper, the army worm, and the forest tent caterpillar. Fungous and other plant diseases often cause great destruction to trees or other plants in particular

regions, and sometimes bring about a great change in the local fauna or sylva by practically eliminating certain species. A good example of this is the chestnut blight, which has practically exterminated the chestnut tree in many localities.

Drought, particularly if prolonged, is a very important element in humid or semi-humid regions, and, while it usually has little effect upon the forest, it often eliminates at least temporarily many of the succulent plants. On swamps, marshes, streams, and lakes a prolonged and severe drought has a still more disastrous affect, often exterminating entirely the plants which depend upon much water. The affect of drought is usually not permanent, particularly if water subsequently returns in sufficient quantity.

Floods are more dangerous, and if severe often sweep away the entire vegetation of an area, taking with it even the soil that supported the plants and without which they could not exist. This happens commonly to the grass and annuals; to the shrubs, and even to the trees on such areas as the more or less level bottomlands of rivers; and much of this destruction is irreparable.

Storms, particularly of wind, often destroy large areas of forest, which, thus, in many cases permanently disappear. Such storms are particularly disastrous to the live oak forests of the coast plain. A tornado has a similar though more limited effect on the pines and other woodlands where a broad path is cut through the woods and all the standing timber destroyed. In such cases the subsequent growth is of an entirely different character. The effect of storms upon brushy vegetation is much less marked, but the succulent growth of annuals and other small plants is often made impossible by the storms which sweep over them a deep layer of mud or sand.

Fire is undoubtedly one of the most destructive agents to forest and thicket alike. Forest areas completely burned do not readily become re-forested, and often lie bare for many years. The woody growth that succeeds is usually of other species than those that were destroyed. Thickets and chaparral are often eliminated just as completely. The frequent fires which formerly swept the coast prairies un-

doubtedly kept down the growth of mesquite; for, since these fires have practically ceased, the mesquite is again springing up over large areas. Fire has less effect on grass than on the more shrubby vegetation, indeed, probably little except temporarily. The same is likewise true of the reeds and rushes in the marshes.

Man is probably the most potent and far-reaching agency in the alteration of vegetation. This is particularly true of changes that consist in rapid and widespread destruction, since constructive alterations involve necessarily a longer process. The changes that affect the natural condition of vegetation and that are due to man's influence are chiefly as follows: complete or partial deforestation or forestation, over small or wide areas; the clearing of thickets and brush of various kinds; the draining of lakes, marshes, and swamps; the formation of lakes and other bodies of water, thereby attracting various water plants; and the alteration of stream courses. In addition to these, the very important element of cultivation must be considered in this connection. This has particular reference to the planting of orchards, of various shade and ornamental trees and hedges, of broad, wide stretches of grassy meadows; the sowing of various kinds of grain, including particularly rice; the planting of various other fodder and other crops, the fields of which after harvest become breeding places for enormous numbers of wild plants. So important is this matter of cultivation that the entire face of the country as well as the interrelationships of the vegetation are thereby altered.

In addition to what has already been mentioned, changes in the flora or sylva of a region sometimes take place from unknown causes. These, as will be noted concerning most of the agencies that cause change, are destructive rather than constructive.

Changes in Bird Life Due to Vegetation.

Since bird life is, as already indicated, so intimately dependent upon vegetation conditions, it follows that alterations in the flora and sylva of a region inevitably cause corresponding changes in the bird life. While of course it is true that some birds are less subject to such influences, be-

cause their habitats are more stable, yet few entirely escape the effect of altered environment. Such changes of environment as take place are probably most marked in the temperate regions, least so in the polar areas and in the most arid deserts. The changes which occur in the bird fauna of any given State or locality concern chiefly increase or decrease of species, but, for convenience, fall into three categories: (1) Appearance and disappearance; (2) increase and decrease; and (3) changes in habit to meet changes in environment. These fluctuations are, to a greater or less extent, continually going on, and are due to either one of two causes or both: the influences of natural phenomena or the changes brought about by man. Those dependent upon natural causes are usually operative over long periods of time, and thus are slow in becoming apparent and often difficult to discover; or they are the result of some catastrophe such as a severe storm or unexpected failure or increase of the food supply. In either case, for obvious reasons, man can do little to influence the operation of these natural forces. With regard, however, to the changes which are due to his own activities he has all power. These result mostly from the clearing of forests, the draining of swamps and marshes, the settling of the country and the consequent cultivation of fields, together with the great destruction of birds for sport or food.

Changes in forest and other vegetation from natural causes or from the settling up of the country and subsequent cultivation have a natural tendency to drive away large birds, such as hawks, eagles, cranes, pelicans, and the like, on account of the elimination or great reduction of their feeding grounds, nesting sites, and shelter. Conversely, such changes often provide places suitable for species new to the region.

Some changes in vegetation are not great or far-reaching enough to eliminate species or to attract others, but cause a greater or less diminution or increase in numbers by new conditions that are favorable or unfavorable, as the case may be. Such is the situation that we most frequently observe, but it may lead eventually to complete extinction of species,

or on the other hand, to the attraction of species foreign to a given area.

Many species of birds of limited range of habitat are utterly unable to adapt themselves to entirely new conditions, so dependent are they on certain factors; as for instance, certain water birds and many strictly forest species, like some woodpeckers; thus, when these factors of their habitat are eliminated the birds are consequently shut out likewise. Such species are, under ordinary circumstances, the first to be exterminated, for they are offered the least opportunity for preservation. Of this, many local instances might be given. Other species are able more or less to adapt themselves to changes in their environment; and to the degree to which they are thus able depends the degree of their salvation. Among birds there are many such cases, as, for instance, the chimney swift, which nested originally in hollow trees, but which the advent of civilization has changed almost universally to the chimneys of buildings; and the cliff swallow, which in settled regions, has largely forsaken its homes on the faces of cliffs for the eaves of barns and other buildings. Many forest birds, on the destruction of the forests in which they live, resort to scattered trees which may be left in cultivated areas or elsewhere, or even to dense chaparral; likewise, birds that live in dense thickets change their abode, on the destruction of their brushy habitat, to the shrubbery of farm land; and other birds which nest in holes of the forest or other trees readily adapt themselves to bird boxes put up by man. Wide-ranging species and those accustomed to a variety of environment, such as many hawks and eagles, are much less influenced by changes in habitat than those of more limited tastes, and are rarely seriously inconvenienced by vegetation changes.

In taking up the direct results of vegetation changes on the birds of Texas, with relation to the above ecological associations, it is of importance to note that a radical alteration of the breeding or feeding place of a species in one association may often eliminate the species from also an adjoining or other association in which it may have been a characteristic species. For instance a shore-bird or other water bird, which had its nesting ground on grassy prairie

and its feeding ground on the beach, would disappear from both associations were its feeding ground for any reason, say cultivation, made unavailable. The same is true of species which, for example, frequent prairie land, but which depend on cover of thickets or woodland for their existence.

In the following pages it is aimed to show as far as possible what might reasonably be expected to happen to the birds in the best characterized of the associational areas should the character of these areas be entirely altered; but birds often do the unexpected, so that our suggestions can be advanced only tentatively. These changes in avifauna are predicated upon actual observations of changed and changing environmental conditions in various parts of Texas and elsewhere. In this the treatment is by manner of change rather than by geographic area, but correlation with the associational areas already delineated may easily be made, and in cases of change from present conditions a reference to the associational lists will show at a glance where the eliminated species would settle, as well as in case of the formation of a new association of plants what birds would be attracted. The increase or decrease of species consequent upon a radical change of environment is not so easy to estimate, for such fluctuations are complicated by other factors, and little or no attempt is here made to discuss such changes. Alterations in habit for the purpose of adaptation to a changed environment are of course much easier to see, and in most cases will be evident without having special attention drawn to them. As will be noticed from the following lists of species, only a small proportion of the birds of any region will actually disappear as the result of even a radical change in character of environment, since by far the larger number soon adapt themselves to their new conditions. The species that do disappear are such as are dependent on certain environment, i. e., characteristic species.

Deforestation and Forestation.

The upland pine forests of eastern Texas harbor no species of bird which is peculiar to them, with the single exception of the pine warbler (*Dendroica pinus pinus*), and this bird would probably disappear were all the pine trees re-

moved. All other species that live in the pine forests or their undergrowth would probably soon become accustomed to other woodland habitats.

In the upland oak and other mixed forests of the eastern uplands there are no species of birds which would disappear were these forests removed, so long as there were other suitable forests remaining, since the birds would soon take up their abode in any other woodlands available.

Of birds confined to the swamps and humid bottomland forests of eastern Texas there are only three that are entirely dependent upon the presence of the forest here, and these three would undoubtedly vanish were the forests removed.

These are:

Campephilus principalis
Dendroica cerulea
Protonotaria citrea

If both trees and thickets were destroyed in these areas, suitable homes under the changed conditions would be found for nearly all the species, but the following birds in addition to those given above would doubtless also be eliminated:

Wilsonia citrina
Oporornis formosus
Seiurus motacilla
Helmitheros vermivorus
Limnothypis swainsonii

The destruction of all the forests on both uplands and lowlands throughout the eastern part of the State would result in a much larger elimination of species, although only a comparatively small proportion of the total bird population would disappear. The rest would adapt themselves to their new environment by finding homes in thickets or cultivated areas. Those dependent closely on the forest and apparently doomed to extinction under such a condition as this are as follows:

Buteo lineatus alleni
Ictinia misisippiensis
Elanoides forficatus forficatus
Centurus carolinus
Phloeotomus pileatus pileatus
Phrenopicus borealis
Dryobates villosus villosus
Dryobates villosus audubonii
Strix varia alleni
Hylocichla mustelina
Sitta pusilla
Sitta carolinensis cookei
Oporornis formosus
Dendroica pinus pinus
Dendroica dominica albilora
Dendroica cerulea
Compsothypis americana ramalinae
Protonotaria citrea

Forestation of any area in this eastern region would of course bring with it the forest association, particularly the birds listed above as reasonably sure to disappear with the forest.

Forestation of all the eastern and central prairies of the State (coast and inland considered together) would so change the character of the country that a number of species unable or unwilling to live in a forested region would probably disappear. Such species are included in the following list:

Tympanuchus americanus attwateri
Colinus virginianus virginianus
Oxyechus vociferus vociferus
Numenius americanus americanus
Catoptrophorus semipalmatus semipalmatus
Himantopus mexicanus
Larus atricilla megalopterus
Gelochelidon nilotica aranea
Hydroprogne caspia imperator
Thalasseus maximus
Thalasseus sandvicensis acuflavidus
Sterna forsteri
Sterna hirundo
Sternula albifrons antillarum
Speotyto cunicularia hypugaea
Muscivora forficata
Otocoris alpestris giraudi
Hirundo rustica erythrogastris
Stelgidopteryx serripennis serripennis
Progne subis subis
Geothlypis trichas trichas
Sturnella magna argutula
Sturnella magna hoopesi
Agelaius phoeniceus phoeniceus (=floridanus)
Megaquiscalus major major
Megaquiscalus major macrourus
Quiscalus quiscula aeneus
Molothrus ater ater
Molothrus ater obscurus
Ammodramus savannarum bimaculatus
Chondestes grammacus strigatus
Spiza americana
Passer domesticus domesticus

The fringes of trees along the streams of the Great Plains, which, with the exception of the small isolated groves about ranch houses, are the only approach to a forest in this region, form an exceedingly attractive place for many kinds of birds. The removal of these fringes of trees would without much doubt cause the disappearance of birds in the following list, just as the natural or artificial extension of such fringes of timber would attract the same species:

Buteo lineatus alleni
Ictinia misisippiensis
Elanoides forficatus forficatus
Colaptes auratus luteus
Centurus carolinus
Melanerpes erythrocephalus erythrocephalus
Dryobates villosus villosus
Otus asio aikeni
Myiarchus cinerascens cinerascens
Myiarchus crinitus crinitus
Tyrannus verticalis
Icterus bullockii bullockii
Icterus galbula

The trees along the streams and in the canyons of the desert areas form likewise an unusual attraction to birds because of the scarcity of arboreal vegetation in such regions. However, the removal of these trees, if the thickets in the same localities were left, would cause the probable disappearance of only a comparatively small number of species. Conversely, the appearance of trees in similar localities would undoubtedly draw the same additional species. A list of these follows:

Coccyzus americanus occidentalis
Colaptes cafer collaris
Pyrocephalus rubinus mexicanus
Horizopus richardsonii richardsonii
Tyrannus verticalis
Lanivireo solitarius plumbeus
Vireosylva gilva swainsonii
Vireosylva olivacea
Icterus bullockii bullockii
Piranga rubra rubra, or *Piranga rubra cooperi.*

The oak and other deciduous forests on the mountains of Texas west of the Pecos River have a great influence on the avifauna. Were these forests all removed, leaving only the undergrowth and the chaparral, the species in the subjoined list would probably follow. Some of these are now to be found in the chaparral below the mountain forests, but occur there largely as visitors from the woodlands, and would disappear if the woods above them ceased to furnish a satisfactory retreat. All but one, *Coccyzus americanus occidentalis*, however, would find refuge in adjoining coniferous forests, if such there were. Conversely, the forestation of mountains with oak and other deciduous forests would attract to a large extent the same list of species. These birds are:

Meleagris gallopavo merriami
Chloroenas fasciata fasciata
Coccyzus americanus occidentalis
Colaptes cafer collaris
Balanosphyra formicivora formicivora, or *Balanosphyra formicivora aculeata*
Otus flammeolus
Setochalcis vocifera arizonae
Cyanolaemus clemenciae bessophilus
Selasphorus platycercus
Nuttallornis borealis majorinus
Horizopus richardsonii richardsonii
Sialia mexicana bairdi
Turdus migratorius propinquus
Sitta carolinensis nelsoni
Penthestes gambeli gambeli
Baeolophus inornatus griseus
Baeolophus atricristatus atricristatus
Cyanocitta stelleri macrolopha
Aphelocoma sieberii couchii
Vireo huttoni stephensi
Lanivireo solitarius plumbeus

Vireosylva olivacea
Piranga ludoviciana
Piranga hepatica oreophasma
Piranga rubra cooperi
Hedymeles melanocephalus papago

The pinyon and juniper forests of these mountains harbor a considerable number of species which are more or less dependent on forest conditions; therefore, if the trees were removed, these species would either be exterminated or forced to seek other areas. All except one, *Cyanocephalus cyanocephalus*, would readily find a home in other coniferous forests elsewhere on the mountains, or in the deciduous woods adjacent. In all these mountain forests there is of course a large number of species that live in the undergrowth, the thickets along the streams, or in the chaparral of slopes and valleys, and which, therefore, are not dependent on the actual presence of the forest trees. These of course would remain. The species that probably would disappear or remove with the pinyon and juniper forest are:

Meleagris gallopavo merriami
Chloroenas fasciata fasciata
Colaptes cafer collaris
Balanosphyra formicivora formicivora, or *Balanosphyra formicivora aculeata*
Sphyrapicus varius nuchalis
Dryobates villosus leucothorectis
Otus flammeolus
Setochalcis vocifera arizonae
Cyanolaemus clemenciae bessophilus
Selasphorus platycercus
Nuttallornis borealis majorinus
Horizopus richardsonii richardsonii
Sialia mexicana bairdi
Turdus migratorius propinquus
Sitta pygmaea pygmaea
Sitta carolinensis nelsoni
Penthestes gambeli gambeli
Baeolophus inornatus griseus
Baeolophus atricristatus atricristatus
Cyanocitta stelleri macrolopha
Aphelocoma sieberii couchii
Cyanocephalus cyanocephalus
Vireo huttoni stephensi
Lanivireo solitarius plumbeus
Dendroica auduboni memorabilis
Piranga ludoviciana
Piranga hepatica oreophasma
Piranga rubra cooperi
Hedymeles melanocephalus papago
Junco dorsalis

The mountain forest of pine, spruce, and cypress have likewise an important influence on the bird life; and while, as in the case of the other mountain forests, many brush-inhabiting species would soon adapt themselves to the lack of trees, there are a number of birds, as shown by the list below, whose extermination in the area would, it appears probable, follow the removal of the forests. However, all

but those marked with an asterisk (*) would readily remove to either the pinyon and juniper or to the deciduous woods on other slopes of the mountains.

Meleagris gallopavo merriami
Chloroenas fasciata fasciata
Colaptes cafer collaris
Balanosphyra formicivora formicivora or *Balanosphyra formicivora aculeata*
Sphyrapicus varius nuchalis
Dryobates villosus leucothorectis
Otus flammeolus
**Strix occidentalis lucida*
Setochalcis vocifera arizonae
Cyanolaemus clemenciae bessophilus
Selasphorus platycercus
Nuttallornis borealis majorinus
Horizopus richardsonii richardsonii
**Empidonax difficilis*
Sialia mexicana bairdi
Turdus migratorius propinquus
Sitta pygmaea pygmaea
Sitta carolinensis nelsoni
Penthestes gambeli gambeli
Cyanocitta stelleri macrolopha
Aphelocoma sieberii couchii
Vireo huttoni stephensi
Lanivireo solitarius plumbeus
Dendroica auduboni memorabilis
Piranga ludoviciana
Piranga hepatica oreophasma
**Hedymeles melanocephalus papago*
**Junco dorsalis*
**Loxia curvirostra stricklandi*

Destruction and Extension of Thickets.

Thickets form one of the most attractive places for birds, and many species are dependent largely, if not wholly, on them for shelter and nesting sites. Many others, however, which frequent them are at home in other environment, and all such, of course, in case of necessity, readily adapt themselves to a change. Complete destruction of the thickets in the swamps and humid bottomlands of eastern Texas would, it seems likely, cause the disappearance of the subjoined birds:

Rubicola minor
Vireo bellii bellii
Vireo griseus griseus
Wilsonia citrina
Icteria virens virens
Geothlypis trichas trichas
Oporornis formosus
Helmitheros vermivorus
Limnothlypis swainsonii
Richmondena cardinalis magnirostris

Elimination of thickets along the streams of the Great Plains, leaving only the fringe of scattered timber, would be liable to extirpate there the following birds:

Geococcyx californianus
Empidonax traillii brewsteri
Toxostoma rufa longicauda
Polioptila caerulea caerulea
Vireo bellii bellii
Vireo griseus griseus
Icteria virens longicauda
Geothlypis trichas occidentalis

Dendroica aestiva morcomi
Richmondena cardinalis cardinalis or *Richmondena cardinalis magnirostris*
Amphispiza bilineata bilineata
Peucaea cassinii
Chondestes grammacus strigatus
Spiza americana

The thickets along the streams and in the canyons of the desert region are especially attractive to birds, doubtless partly on account of the proximity of water, and their removal would be a corresponding calamity to the bird life. Some species which frequent them would make their home in the adjoining chaparral, but many species would probably disappear entirely, even if the trees of the canyons were left; consequently a growth of thickets in a watered canyon would bring thither practically the same list of species, which is as follows:

Chaemepelia passerina pallescens
Geococcyx californianus
Empidonax traillii brewsteri
Toxostoma crissalis
Toxostoma curvirostris curvirostris
Polioptila melanura
Polioptila caerulea obscura
Thryomanes bewickii eremophilus
Thryothorus ludovicianus ludovicianus
Auriparus flaviceps flaviceps
Vireo bellii bellii, or *Vireo bellii medius*, or *Vireo bellii arizonae*
Vireo atricapillus
Icteria virens longicauda
Geothlypis trichas occidentalis
Dendroica aestiva sonorana
Richmondena cardinalis canicauda
Pyrrhuloxia sinuata texana, or *Pyrrhuloxia sinuata sinuata*
Passerina versicolor versicolor
Amphispiza bilineata bilineata, or *Amphispiza bilineata deserticola*
Peucaea cassinii
Aimophila ruficeps scottii, or *Aimophila ruficeps eremoeca*

Wherever extensive thickets or areas of brush exist on the eastern uplands of the State they form, as elsewhere, excellent habitats for birds. Their loss, were they replaced by vegetation no more protective to bird life than grass, would, without much doubt, cause the disappearance of such of the following birds as occur in any particular locality thus denuded:

Geococcyx californianus
Coccyzus americanus americanus
Colaptes auratus auratus
Melanerpes erythrocephalus erythrocephalus
Dryobates pubescens pubescens
Otus asio asio
Antrostomus carolinensis
Horizopus virens
Empidonax traillii brewsteri
Empidonax minimus
Myiarchus crinitus crinitus
Dumetella carolinensis
Polioptila caerulea caerulea
Thryomanes bewickii cryptus
Thryothorus ludovicianus ludovicianus
Sitta carolinensis cookei

Penthestes carolinensis carolinensis
Baeolophus bicolor
Cyanocitta cristata cristata (=florincola)
Vireo bellii bellii
Vireo griseus griseus
Lanivireo flavifrons
Icteria virens virens
Geothlypis trichas trichas
Dendroica discolor
Dendroica aestiva aestiva
Icterus galbula
Icterus spurius
Piranga rubra rubra
Richmondena cardinalis magnirostris
Guiraca caerulea caerulea
Passerina ciris ciris
Passerina ciris pallidior
Passerina cyanea
Peucaea aestivalis illinoensis

Destruction of the thickets on the coast prairies of the eastern part of the State, leaving only a grassy area, would naturally result in the disappearance of a number of birds which are practically dependent on such vegetation, particularly in areas which have no forest. These birds are included in the subjoined list:

Meleagris gallopavo silvestris
Colaptes auratus auratus
Melanerpes erythrocephalus erythrocephalus
Dryobates pubescens pubescens
Antrostomus carolinensis
Polioptila caerulea caerulea
Thryothorus ludovicianus ludovicianus
Penthestes carolinensis carolinensis
Vireo bellii bellii
Vireo griseus griseus
Icteria virens virens
Geothlypis trichas trichas
Richmondena cardinalis magnirostris
Guiraca caerulea caerulea
Paserina ciris ciris
Spizella passerina passerina

Destruction and Extension of Chaparral

The chaparral that covers the level or rolling country in the central southern part of Texas forms one of the most important factors in the distribution of bird life in all the State. It furnishes shelter and suitable nesting sites for a very large number of species, particularly such as depend on cover for protection and food. The entire destruction of this chaparral, leaving only a bare or grassy area, would probably have a more profound effect on the avifauna than the destruction of any other kind of vegetation in any part of the State. The species that, it seems, would thereby be practically eliminated from the region in question are comprised in the following list. Some of these of course might eke out a scanty existence under the changed environment, but few of them would remain at all. The list is as follows:

Rhynchofalco fuscocoerulescens septentrionalis
Buteo borealis borealis
Buteo lineatus alleni
Buteo lineatus texanus
Buteo platypterus platypterus
Urubitinga anthracina
Parabuteo unicinctus harrisi
Ortalis vetula vetula
Meleagris gallopavo intermedia
Melopelia asiatica asiatica
Leptotila fulventris angelica
Chloroenas flavirostris flavirostris
Crotophaga sulcirostris sulcirostris
Geococcyx californianus
Coccyzus americanus americanus
Centurus aurifrons
Centurus carolinus
Phloeotomus pileatus pileatus
Dryobates scalaris symplectus
Glaucidium brasilianum ridgwayi
Bubo virginianus virginianus
Bubo virginianus pallescens
Otus asio mccallii
Strix varia helveola
Antrostomus carolinensis
Phalaenoptilus nuttallii nuttallii
Nyctidromus albicollis merrilli
Amazilia yucatanensis chalconota
Camptostoma imberbe
Pyrocephalus rubinus mexicanus
Horizopus virens
Empidonax minimus
Myiarchus cinerascens cinerascens
Myiarchus magister nelsoni
Myiarchus crinitus crinitus
Pitangus sulphuratus derbianus
Toxostoma curvirostris curvirostris
Toxostoma longirostris sennetti
Mimus polyglottos leucopterus
Polioptila melanura
Polioptila caerulea caerulea
Thryomanes bewickii cryptus
Thryothorus ludovicianus ludovicianus
Thryothorus ludovicianus lomitensis
Heleodytes brunneicapillus couesi
Auriparus flaviceps flaviceps
Penthestes carolinensis agilis
Baeolophus atricristatus atricristatus
Baeolophus atricristatus sennettii
Baeolophus bicolor
Xanthoura luxuosa glaucescens
Vireo bellii bellii
Vireo griseus griseus
Vireo griseus micrus
Lanivireo flavifrons
Icteria virens virens
Icteria virens longicauda
Chamaethlypis poliocephala poliocephala
Dendroica aestiva aestiva
Icterus bullockii bullockii
Icterus cucullatus sennetti
Icterus melanocephalus audubonii
Icterus spurius
Richmondena cardinalis canicauda
Pyrrhuloxia sinuata texana
Guiraca caerulea lazula
Passerina versicolor versicolor
Passerina ciris pallidior
Arremonops rufivirgatus rufivirgatus
Amphispiza bilineata bilineata
Peucaea cassinii
Astragalinus psaltria psaltria

When on the level grassy coast prairies the chaparral spreads and usurps the land, it brings with it practically all the species in the above list, but incidentally at the same time it usually causes the disappearance of the following prairie-dwelling species:

Tympanuchus americanus attwateri
Rallus longirostris saturatus
Oxyechus vociferus vociferus

Catoptrophorus semipalmatus semipalmatus
Himantopus mexicanus
Otocoris alpestris giraudi
Sturnella magna argutula, or *Sturnella magna hoopesi*
Thryospiza maritima fisheri, or *Thryospiza maritima sennetti*

Likewise in the central broken area of Texas, where the chaparral covers the hills and dales, its destruction anywhere, leaving only the grass behind, apparently eliminates such of the following large number of birds as live in that particular locality:

Buteo lineatus texanus
Meleagris gallopavo intermedia
Geococcyx californianus
Coccyzus americanus americanus
Coccyzus americanus occidentalis
Centurus aurifrons
Centurus carolinus
Balanosphyra formicivora formicivora
Melanerpes erythrocephalus erythrocephalus
Phloeotomus pileatus pileatus
Dryobates scalaris symplectus
Dryobates pubescens pubescens
Otus asio hasbroucki
Strix varia helveola
Antrostomus carolinensis
Phalaenoptilus nuttallii nuttallii
Archilochus alexandri
Archilochus colubris
Horizopus virens
Empidonax traillii brewsteri
Empidonax minimus
Myiarchus cinerascens cinerascens
Myiarchus crinitus crinitus
Polioptila caerulea caerulea
Thryothorus ludovicianus ludovicianus
Heleodytes brunneicapillus couesi
Sitta carolinensis carolinensis (=aikeni)
Penthestes carolinensis agilis
Baelophus atricristatus sennetti
Baeolophus bicolor
Cyanocitta cristata bromia
Aphelocoma californica texana
Vireo bellii bellii
Vireo griseus griseus
Vireo atricapillus
Lanivireo flavifrons
Icteria virens virens
Dendroica chrysoparia
Dendroica aestiva aestiva
Icterus bullockii bullockii
Icterus spurius
Richmondena cardinalis canicauda
Pyrrhuloxia sinuata texana
Guiraca caerulea lazula
Passerina ciris pallidior
Passerina amoena
Passerina cyanea
Amphispiza bilineata bilineata
Peucaea cassinii
Astragalinus psaltria psaltria

The chaparral that covers the desert plains and mesas in the trans-Pecos region is likewise a very important factor in the bird life. The removal of this vegetation, which furnishes food, shelter, and nesting sites for a large bird population, leaving only short grass or bare ground over its entire present area in the State, would probably cause the disappearance of the following birds:

Rhynchofalco fuscocoerulescens septentrionalis

Lophortyx gambelii gambelii
Callipepla squamata pallida
Colinus virginianus texanus
Chaemepelia passerina pallescens
Scardafella inca
Geococcyx californianus
Centurus aurifrons
Dryobates scalaris symplectus
Dryobates scalaris cactophilus
Otus asio cineraceus
Phalaenoptilus nuttallii nuttallii
Archilochus alexandri
Pyrocephalus rubinus mexicanus
Horizopus richardsonii richardsonii
Myiarchus cinerascens cinerascens
Tyrannus verticalis
Tyrannus vociferans
Toxostoma crissalis
Toxostoma curvirostris curvirostris
Mimus polyglottos leucopterus
Polioptila melanura
Polioptila caerulea obscura
Thryomanes bewickii cryptus
Thryomanes bewickii eremophilus
Heleodytes brunneicapillus couesi
Auriparus flaviceps flaviceps
Aphelocoma californica texana
Aphelocoma californica woodhouseii
Vireo bellii bellii
Vireo bellii medius
Vireo bellii arizonae
Icteria virens longicauda
Icterus parisorum
Icterus cucullatus sennetti
Icterus spurius
Richmondena cardinalis canicauda
Pyrrhuloxia sinuata texana
Pyrrhuloxia sinuata sinuata
Guiraca caerulea lazula
Passerina versicolor versicolor
Passerina ciris pallidior
Passerina amoena
Spizella passerina arizonae
Amphispiza bilineata bilineata
Amphispiza bilineata deserticola
Peucaea cassinii
Astragalinus psaltria psaltria

Destruction and Extension of Herbaceous Vegetation.

The open grassy prairies in the eastern and middle portions of Texas, including the coast region, have a more or less peculiar avifauna. The removal of the grass and other herbaceous vegetation, leaving only the bare ground, causes usually the departure of the following birds:

Dendrocygna autumnalis
Meleagris gallopavo silvestris
Tympanuchus americanus attwateri
Colinus virginianus virginianus
Rallus longirostris saturatus
Chaemepelia passerina pallescens
Otus asio asio
Strix varia alleni
Archilochus colubris
Geothlypis trichas trichas
Sturnella magna argutula
Agelaius phoeniceus phoeniceus (=floridanus)
Thryospiza maritima fisheri
Ammodramus savannarum bimaculatus
Spiza americana

The hydrophytic vegetation of the lakes and ponds on the Great Plains in Texas does not harbor a large number of species of birds, but a few of these would doubtless disap-

pear following the destruction of this vegetation. These are:

Botaurus lentiginosus
Fulica americana
Xanthocephalus xanthocephalus
Agelaius phoeniceus fortis

The marshes of the eastern coast of Texas have likewise a somewhat peculiar avifauna. Practically all of the species which nest here are directly dependent on the distinctively marsh vegetation, and they naturally disappear with this. These birds are:

Colymbus dominicus brachypterus
Ixobrychus exilis exilis
Botaurus lentiginosus
Querquedula discors
Dendrocygna bicolor
Fulica americana
Gallinula chloropus cachinnans
Porphyrula martinica
Rallus longirostris saturatus
Tyrannus tyrannus tyrannus
Telmatodytes palustris thryophilus
Geothlypis trichas trichas
Agelaius phoeniceus phoeniceus (=floridanus)
Thryospiza maritima fisheri

Cultivation.

The settlement of an area of country by man has its inevitable effect upon the bird life. The consequent change in vegetation often displaces species not suited to the changed environment or to the disturbance of natural conditions that the presence of man occasions. On the other hand, it creates a favorable environment for additional species by providing an abundant food supply and suitable surroundings, and birds accordingly follow up the advance of civilization. Among these influences might be mentioned the draining of swamps, the cutting down of forests, the creation of grain fields and meadows, and the planting of ornamental trees and shrubbery. The cultivation of the country, moreover, serves in the same way to attract increased numbers of some species of birds. There is no more conspicuous example of this than the rice fields of the coast prairies, which in a way, supply the place of marshes. They draw multitudes of the red-winged (*Agelaius*) and other blackbirds, the three species of grackles (*Quiscalus quiscula aeneus*, *Megaquiscalus major major*, and *Megaquiscalus major macrourus*), the cowbirds (*Molothrus ater ater* and *Molothrus ater obscurus*); also great numbers of geese, ducks, terns, shorebirds, and herons, particularly the little blue heron (*Florida caerulea caerulea*). The cultivation of the uplands, especial-

ly in parts of eastern Texas, has also had the effect of increasing the numbers of certain birds, and for similar reasons. Among such species might be mentioned the red-headed woodpecker (*Melanerpes erythrocephalus erythrocephalus*), the wood pewee (*Horizopus virens*), the mocking-bird (*Mimus polyglottos polyglottos*), the common crow (*Corvus brachyrhynchos brachyrhynchos*), the meadowlark (*Sturnella magna magna*), the field sparrow (*Spizella pusilla pusilla*), and the chipping sparrow (*Spizella passerina passerina.*) Some species take so readily to the advent of men that they have even changed their breeding habits, and now nest often or exclusively about his habitations or in boxes put up for their convenience. Conspicuous among such species are the phoebe (*Sayornis phoebe*), the chimney swift (*Chaetura pelagica*), the purple martin (*Progne subis*), the barn swallow (*Hirundo rustrica erythrogastris*), the cliff swallow (*Petrochelidon albifrons albifrons*), the bluebird (*Sialia sialis sialis*), the Texas wren (*Thryomanes bewickii cryptus*), and the Carolina wren (*Thryothorus ludovicianus ludovicianus*).

The changes that cultivation and the proximity of human habitations occasion may readily be seen by comparing the bird list on pages 593—596 for the Eastern Agrarian Association with the lists of birds for other associations in various kinds of habitats that might be converted into cultivated areas.

Changes in Bird Life not Due to Vegetation.

Many changes in bird life take place which are not properly attributable to changes in vegetation. Of these there are at least six direct causes: (1) natural enemies; (2) diseases; (3) storms and floods; (4) drought; (5) fires; and (6) man. Although, of course, strictly these should not be included with the effects of vegetation, they are here added for the sake of completeness.

The natural enemies of birds are chiefly mammals (including cats) and rapacious birds. Loss of life is the chief effect that these natural enemies have on birds. It is seldom, however, that a species of bird is wholly exterminated through the agency of its natural enemies, though these

enemies serve often greatly to reduce its numbers, particularly within small areas.

Diseases sometimes deplete the ranks of birds locally, but rarely ever have any disastrous effect upon the species as a whole.

Storms and floods at times have a very important bearing on the distribution and fluctuation in the numbers of birds. In addition to their indirect influence by the destruction of forests and other suitable nesting sites, which often drives away from certain localities the birds that were nesting there, severe storms, particularly during the migration season, have been known to destroy thousands of birds at a time, thus reducing very materially the total number of individuals. Storms and floods during the nesting period frequently destroy the nests of birds over a wide area, particularly water birds, shore-birds, and other species that build open nests on the ground.

A prolonged drought in regions where birds depend much upon water for both nesting sites and for the aquatic vegetation which supplies their food sometimes results in considerable loss of bird life, and in this way occasions considerable fluctuation in the abundance of certain species. This, however, is one of the least important influences that affect bird life.

Fires in prairie regions, especially during the breeding season, are very destructive to ground-nesting birds, like prairie chickens and small sparrows, and in certain instances have locally caused practical extermination of some species.

The most potent influence in the reduction of the numbers of certain birds is the hunter who pursues them for sport or for their plumage or for food. This has caused much reduction of birds in Texas. Three species have, wholly or partly by means of this, become entirely or practically extinct: the passenger pigeon (*Ectopistes canadensis*), the Louisiana paroquet (*Conuropsis carolinensis ludovicianus*), and the Eskimo curlew (*Mesoscolopax borealis*). Others which everywhere have been very much depleted in numbers by hunting are the whooping crane (*Leucogeranus americanus*), the trumpeter swan (*Cygnus buccinator*), the whist-

ling swan (*Cygnus columbianus*), the wild turkeys (*Meleagris gallopavo silvestris* and *Meleagris gallopavo intermedia*), and the prairie chickens (*Tympanuchus americanus americanus* and *Tympanuchus americanus attwateri*). Hunting has had a decided effect on the numbers of also the brown pelican (*Pelecanus occidentalis occidentalis*), upon the curlews, sandpipers, particularly *Bartramia longicauda*, some species of plovers, especially the golden plover (*Pluvialis dominica dominica*), ducks, especially the wood duck (*Aix sponsa*), and the various species of geese. None, however, have suffered more than the gulls, terns, herons, and their allies, which have been persistently and relentlessly pursued by the plume hunter. Those birds that have most decreased from this cause are the laughing gull (*Larus atricilla megalopterus*), the gull-billed tern (*Gelochelidon nilotica aranea*), the common tern (*Sterna hirundo*), the least tern (*Sternula albifrons antillarum*), the royal tern (*Thalasseus maximus*), the snowy egret (*Leucophoyx thula thula*), the American egret (*Casmerodius alba egretta*), the wood ibis (*Mycteria americana*), the white ibis (*Guara alba*), the roseate spoonbill (*Ajaia ajaja*), and the black skimmer (*Rynchops nigra*).

On the other hand, man often, by protecting and encouraging the birds about him, partially at least counteracts the effect of the injury that his activities do to bird life. By this, not only do birds increase in numbers in the areas under protection, but frequently there appear species that before were not known in the locality. Furthermore, in Texas a few colonies of birds seem to be growing larger as the result of protection. This concerns principally the royal tern (*Thalasseus maximus*), the least tern (*Sternula albifrons antillarum*), the laughing gull (*Larus atricilla megalopterus*), and the black skimmer (*Rynchops nigra*).

Another means of furthering bird life, that of introduction from other regions, though carried out with success in some other States, has been little tried in Texas. The most conspicuous example of this, so far as Texas is concerned, is the English sparrow (*Passer domesticus domesticus*), which, originally introduced into Texas at several localities, has spread over practically the entire State and is still on the

increase. A few sporadic and more or less ineffectual attempts have been made to introduce the bob-white (*Colinus virginianus*), into some localities in Texas where practically exterminated, and also one or two attempts to import Old World pheasants, but without any permanent success in either case.

(Note.—The unfortunate typographical errors on pages 564—594 of this article are due to the lack of opportunity for proof reading by the author.)

POLYGONATUM COMMUTATUM RAMOSUM.

AN UNUSUAL POLYGONATUM

SISTER VINCENT DE PAUL MCGIVNEY, I. H. M.

On a recent botanical trip at Notre Dame a rather remarkable specimen of Solomon's Seal (*Polygonatum commutatum*) was found, a description of which may prove of interest.

The specimen grew on a woody hillside, one mile southeast of the University. About 5 specimens were grouped together in that spot, and several ordinary Polygonata near it. The plant is now in the Notre Dame herbarium. A copy of the drawing made of it is here reproduced.

The plant in question attracted immediate attention on account of its unusual monopodial branching from the main stem, a habit which is entirely foreign to any species of Polygonatum. It was some 5dm. high; the main stem had about 15 leaves, 8-10cm. long and 4-5cm. wide. From the axil of each leaf a conspicuous branch appeared, ranging in length from about 18cm. on the lower part of the stem to 4 or 5cm. at the apex. The lower branches bore 5 to 6 half-clasping, ovate-lanceolate leaves, like the leaves of the main stem, but smaller, 5-6cm. long, 18-20 mm. wide. The leaves on the branches towards the apex were fewer and much smaller.

As the season of flowering was past the plant bore only the fruit. This in the form of green, globular berries appeared on the under side of the branches on short pedicels 2.5-3cm. in length, joined near the fruit. There were from 4 to 6 berries on the lower, larger branches and none on the shorter, apical ones. There was no fruit at all borne on the main stem as is ordinarily the case in Polygonatum.

Whether this plant may become a new variety of *Polygonatum commutatum* or is simply a branching form of the species that appears only to disappear again remains for future observation. The rootstock was not disturbed and several small plants left for future reference.

As far as could be ascertained no similar specimens of Polygonatum have been reported from this section of the country, although one quite like it was found at Christiana Lake, Mich., north of Elkhart, Ind., in the summer of 1924.

Polygonatum commutatum forma **ramosum.**

Planta de rhizomate reptante et nodosa oriens, sicut in typica. Caulis singularis, robustus, erectus, teres, 5dm. altus, glabra. Folia oblonga et apicem versus sensim angustata, integra, sessilia 8-10cm. longa, 4-5 lata, alternata in cauli et secunda. *A. P. Commutato* differt eo quod ex axillis foliorum ramos manifestos prope 18cm. longos basi et 5cm. apici habet. Folia ramulorum sessilia ovata et breviora quam ea in cauli, 4 usque 5 fructus globularis, virides sub ramis, in pedicelibus brevibus, 2-3cm. in longitudine feruntur. Cauli principali omnino desunt flores vel fructus.

Planta 22003, Nostrae Dominae, Ind., in silva sub Quercus die 14 Julii, 1925, collecta typica. Alia 22002 proxima Lacu Christiana, Mich., australi mensis Aug. 10, 1924, similis est praecedentibus.

Missouri Botanical Garden Library
3 1753 00215 6815

QK1 .A423 1924/25 v.9

The American midland naturalist

DATE DUE